OCCASIONAL PAPERS
OF THE
CALIFORNIA ACADEMY OF SCIENCES

No. 146, 71 pages. February 25, 1987

# PALEOZOIC POLYPLACOPHORA: A CHECKLIST AND BIBLIOGRAPHY

by
Allyn G. Smith
*California Academy of Sciences, San Francisco, California 94118*

and
Richard D. Hoare
*Department of Geology, Bowling Green State University, Bowling Green, Ohio 43403*



ABSTRACT: An annotated checklist of 130 accepted species of Paleozoic polyplacophorans, as of 1985, is presented including complete synonymies, geological age, occurrences, location of specimens, and remarks. Reassignment within the classification is made, where possible, and a systematic arrangement is given. Fourteen species, based upon present information are indeterminate as to generic placement and 15 additional taxa, originally described as polyplacophorans, are here rejected. In addition, a list of 23 occurrences of unnamed specimens is included for completeness of known distribution. A bibliography of 193 citations contains all pertinent references to Paleozoic material included within the Class Polyplacophora, whether or not the taxonomic assignment is acceptable.

Known Paleozoic polyplacophoran taxa are about equally distributed geographically between Great Britain, continental Europe, and North America. Stratigraphically, the largest number of described taxa are from Mississippian and Ordovician strata. Of the 153 named and unnamed taxa, 74 are Lower Paleozoic (Cambrian–Devonian) and 79 are Upper Paleozoic (Mississippian–Permian).

New taxa proposed herein are: *Acutichiton etheridgei* n. sp., *Lekiskochitonidae* n. fam.

## FOREWORD

Allyn G. Smith was in the process of compiling a comprehensive checklist and bibliography on Paleozoic polyplacophorans at the time of his death in August 1976. Smith's unfinished manuscript was forwarded to Ellis L. Yochelson, U.S. Geological Survey, Washington, D.C. upon his death. Yochelson asked R. D. Hoare, Department of Geology, Bowling Green State University, Bowling Green, Ohio to prepare the manuscript for publication.

The manuscript of the checklist and bibliography was submitted to the Editorial Board of the California Academy of Sciences essentially unchanged from the way it was left by Smith at the end of 1975. At the board's request the manuscript was brought up to date, including known work in press, to make it a more useful contribution.

Introductory remarks are modifications of those used by Smith (1973) for his Mesozoic checklist and bibliography. Compilations of age distributions, the revisions of systematic arrangement, and the presentation of a new sys-

tematic arrangement are based upon his remarks and upon work since his death.

## Introduction

An exhaustive review of the literature relating to fossil Polyplacophora (chitons) was made in 1956–60 during the preparation of a synthesis of this class for the Treatise on Invertebrate Paleontology (Smith 1960). The treatise format precluded a listing of described fossil species, except type species, and space requirements permitted publication of only selected references. Thus, for the benefit of future studies, a list of the described species of fossil polyplacophorans was assembled in order to bring together all of the widely scattered information on the group. Species of other groups, initially considered to be polyplacophorans, were included. A checklist and bibliography of Mesozoic Polyplacophora taxa has been published (Smith 1973).

The appended annotated checklist covers all published Paleozoic polyplacophoran occurrences that have been located. All names covered in the literature have been included. The doubtful status of several so-called fossil polyplacophorans, the lack of an adequate number of specimens for other taxa, poorly preserved material, undoubted misidentifications, or a combination of these all present problems for future workers to resolve. The list is arranged alphabetically, by species, each name is followed by a complete synonymy, the geological horizon of occurrence, available data on the type locality and other locations where the species is reported to have been collected, and the location of type and other identified specimens, if known. Pertinent comments are added to the extent that these appear to be needed to provide useful information for a better understanding of the species. Because of space considerations, many original species descriptions have been omitted as these are available from the literature.

For the sake of brevity several institutions which are repeated numerous times, especially under location of material, have been abbreviated. These are:

BGSU—Department of Geology, Bowling Green State University, Bowling Green.
BM (N.H.)—Department of Geology, British Museum of Natural History, London.
CAS—Geology Type Collection, California Academy of Sciences, San Francisco.
MCZ—Museum of Comparative Zoology, Harvard University, Cambridge.
OSU—Orton Museum, Ohio State University, Columbus.
OU—Fossil Invertebrate Repository, University of Oklahoma, Norman.
PSM—School of Mines, Paris.
RM—Natural History Museum (Riksmuseum), Stockholm.
USNM—Department of Paleobiology, U.S. Museum of Natural History, Washington.

The remaining institutions, some 27 in all, are given in full in their appropriate place.

Bibliographic references are complete so far as known. For brevity, references to pages and to plates and figures apply specifically to Paleozoic polyplacophorans or to comments on the occurrence of them in the fossil record.

## Acknowledgments

Particular thanks are due to Dr. H. O. Fletcher of the Australian Museum who provided casts of *Permochiton australianus* and *Chelodes calceoloides* for study. Dr. G. A. Cooper of the Department of Paleobiology, U.S. National Museum, Washington, D.C. was instrumental in providing a loan of the Paleozoic polyplacophorans in the museum. Dr. Harry B. Whittington, while at Harvard University, Cambridge, Massachusetts, loaned the Schultz Collection in the Museum of Comparative Zoology for study. The Department of Geology, University of Minnesota, Minneapolis, Minnesota loaned specimens of *Chelodes gibberosus*. Dr. Ellis L. Yochelson of the U.S. Geological Survey, Washington, D.C. provided numerous references which were otherwise unavailable.

## Paleozoic Polyplacophoran Fauna

The Paleozoic polyplacophoran fauna has well over 150 recorded species, of which 130 named species are believed valid. In addition, 23 occurrences of valves have been reported, for which no names or formal descriptions have been provided. The 153 forms known at present come from the following geological systems (if the position for a taxon in a system is unclear it is included under Lower):

| System | Lower | Middle | Upper | Total |
|---|---|---|---|---|
| Permian | 13 | 8 | 1 | 22 |
| Carboniferous (undifferentiated) | – | – | – | 6 |
| Pennsylvanian | 4 | 10 | 4 | 18 |
| Mississippian | 30 | 2 | 1 | 33 |
| Devonian | 7 | 5 | 8 | 20 |
| Silurian | 4 | 8 | 2 | 14 |
| Ordovician | 21 | 6 | 5 | 32 |
| Cambrian | 2 | – | 6 | 8 |
| | | | Total | 153 |

The Cambrian occurrences are reported from the United States and China. The Ordovician taxa are dominantly found in the United States, with a few scattered reports from Czechoslovakia, Great Britain, Australia, and Canada. Most Silurian taxa are reported from Sweden, with a few occurrences in Ireland, Great Britain, and Australia. The Devonian forms are dominantly from Germany, with a few from France, Czechoslovakia, Austria, Great Britain, Canada, and the United States. The Carboniferous taxa are reported primarily from Great Britain, Belgium, and the United States. Permian taxa are known mainly from Great Britain and the United States, with scattered forms from Australia and Malaysia. The bulk of reported recognized species is approximately evenly divided among Great Britain, continental Europe, and North America.

## Assignment of Species

Any student of the Polyplacophora will be aware of the difficulty of preparing a meaningful systematic arrangement of the known fossil species on the basis of present knowledge. Many earlier-described species were placed in the genus *Chiton,* which was used in a very broad sense; a few were allocated to the genus *Chitonellus. Chiton,* as now restricted, does not include most fossil species and *Chitonellus* is no longer used. Some fossil chiton species were described from a single valve. In most, the full complement of head, intermediate, and tail valves has not been found. This is a serious detriment to any sound conclusions on proper generic and family placement. Of course, the same is true when the quality of the fossils is not good enough to display the characters required for accurate identification.

The differences between many described genera rest on inadequate or imperfect information. Except for a few species, it has not been possible to study European Paleozoic species, as much of the original material is in European museums. For many species the location of type or other specimens from original localities has not been reported in the literature; this should be recorded for the benefit of future studies. No complete systematic arrangement can be developed without a great deal more study of actual type specimens and of related valves from original or equivalent geological formations. The comparison below between the original systematic allocations of Paleozoic polyplacophorans and our assignment is only a short step toward a logical arrangement under appropriate genera, families, and higher taxonomic units.

| Original assignment | Present assignment |
|---|---|
| *Acutichiton allynsmithi* Hoare, Mapes, and Atwater, 1983 | Neoloricata, Acutichitonidae, genus unchanged. |
| *Acutichiton pannuceus* Hoare and Mapes, 1985*b* | Neoloricata, Acutichitonidae, genus unchanged. |
| *Acutichiton pyrmidalus* Hoare, Sturgeon, and Hoare, 1972 | Neoloricata, Acutichitonidae. Type species of *Acutichiton* Hoare, Sturgeon, and Hoare, 1972. |
| *Anatifopsis*? *elongatus* Hadding, 1913 | Paleoloricata, Septemchitonidae, *Solenocaris*? Young and Young, 1868. |
| *Arcochiton raymondi* Hoare and Sturgeon, 1976 | Neoloricata, Acutichitonidae. Type species of *Arcochiton* Hoare and Sturgeon, 1976. |
| *Ascoseras gibberosus* Sardeson, 1896 | Paleoloricata, Mattheviidae, *Chelodes* Davidson and King, 1874. |
| *Bursata iowensis* Sanders, 1962 | Paleoloricata, Septemchitonidae, *Septemchiton* Bergenhayn, 1955. |
| *Calceochiton* cf. *C. gibberosus* (Sardeson) Flower, 1968 | Paleoloricata, Mattheviidae, genus unchanged. |
| *Calceochiton hachitae* Flower, 1968 | Paleoloricata, Mattheviidae. Type species of *Calceochiton* Flower, 1968. |

| Original assignment | Present assignment |
|---|---|
| *Calyptraea antiquus* Howse, 1848 | * |
| *Camptochiton squarrosus* DeBrock, Hoare, and Mapes, 1984 | Neoloricata, Lepidopleuridae. Type species of *Camptochiton* DeBrock, Hoare, and Mapes, 1984. |
| *Chauliochiton knighti* Hoare and Smith, 1984 | Neoloricata, Lepidopleuridae. Type species of *Chauliochiton* Hoare and Smith, 1984. |
| *Chelodes bergmani* Davidson and King, 1874 | Paleoloricata, Matthewiidae. Type species of *Chelodes* Davidson and King, 1874. |
| *Chelodes calceoloides* Etheridge, 1897 | Paleoloricata, Matthewiidae, genus unchanged. |
| *Chelodes depressus* Bergenhayn, 1960 | Paleoloricata, Matthewiidae, genus unchanged. |
| *Chelodes gotlandicus* Lindström, 1884 | Paleoloricata, Matthewiidae, genus unchanged. |
| *Chelodes intermedius* Bergenhayn, 1960 | Paleoloricata, Matthewiidae, genus unchanged. |
| *Chelodes longissimus* Bergenhayn, 1955 | Paleoloricata, Matthewiidae, genus unchanged. |
| *Chelodes variegatus* Bergenhayn, 1955 | Paleoloricata, Matthewiidae, genus unchanged. |
| *Chelodes whitehousei* Runnegar, Pojeta, Taylor, and Collins, 1979 | Paleoloricata, Matthewiidae, genus unchanged. |
| *Chiton armstrongianus* Etheridge, 1882 | Neoloricata, Lepidopleuridae, *Gryphochiton*? Gray, 1847*a*. |
| *Chiton barrandeanus* de Ryckholt, 1852 | * |
| *Chiton bohemicus* Barrande, 1867 | Paleoloricata, Matthewiidae, *Chelodes*. |
| *Chiton burrowianus* Kirkby, 1862 | † |
| *Chiton canadensis* Billings, 1865 | Order and family unknown. Type species of *Priscochiton* Dall, 1882. |
| *Chiton carbonarius* Stevens, 1858 | Neoloricata, Lepidopleuridae. Type species of *Glaphurochiton* Raymond, 1910. |
| *Chiton collinensis* Gortani, 1913 | † |
| *Chiton coloratus* Kirkby, 1862 | † |
| *Chiton concentricus* de Koninck, 1842 | Neoloricata, Lepidopleuridae, *Pterochiton*? Carpenter *in* Dall, 1882. |
| *Chiton*? *cordatus* Kirkby, 1859 | Neoloricata, Lekiskochitonidae, *Lekiskochiton*? Hoare and Smith, 1984. |
| *Chiton*? *cordatus*? Kirkby and Young, 1867 | Neoloricata, Lepidopleuridae. See *Gryphochiton*? *acutivalis* (de Koninck, 1883). |
| *Chiton cordatus* Etheridge, 1882 | Neoloricata, Acutichitonidae, *Acutichiton* Hoare, Sturgeon, and Hoare, 1972. |
| *Chiton*? *cordifer* de Koninck, 1842 | Neoloricata, Glyptochitonidae. Type species of *Glyptochiton* de Koninck, 1883. |
| *Chiton cordiformis* Sandberger, 1845 | † |
| *Chiton corrugatus* Sandberger and Sandberger, 1856 [non Reeve, 1848] | Paleoloricata, Chelodidae. Type species of *Proboleaum* Carpenter *in* Dall, 1882. |
| *Chiton dalriensis* Etheridge, 1882 | Neoloricata, Permochitonidae, *Pileochiton* DeBrock, Hoare, and Mapes, 1984. |
| *Chiton eburonicus* de Ryckholt, 1845 | Neoloricata, Lepidopleuridae. Type species of *Pterochiton* Carpenter *in* Dall, 1882. |
| *Chiton exsectionis* Trenkner, 1868 | † |
| *Chiton fasciatus* Sandberger, 1842 | Nomen nudum, preoccupied. Replaced by *Chiton sagittalis* Sandberger and Sandberger, 1853, which is rejected as a chiton for the purpose of this report. |
| *Chiton geikei* Etheridge, 1882 | Neoloricata, Lepidopleuridae, *Chauliochiton*? Hoare and Smith, 1984. |
| *Chiton gemmatus* de Koninck, 1842 | Preoccupied. Replaced by *Chiton subgemmatus* d'Orbigny, 1850. Neoloricata, Lepidopleuridae, *Pterochiton* Carpenter *in* Dall, 1882. |
| *Chiton gibbosus* Trenkner, 1868 | † |
| *Chiton grayanus* de Koninck, 1857 | † |
| *Chiton howseanus* Kirkby, 1857 | Neoloricata, Cymatochitonidae, *Cymatochiton*? Dall, 1882. |
| *Chiton humilis* Kirkby *in* Young, 1865 | † |
| *Chiton inflatus* Trenkner, 1868 | † |
| *Chiton laevigatus* Roemer, 1855 | † |
| *Chiton legiacus* de Ryckholt, 1845 | Neoloricata, Lepidopleuridae, *Pterochiton* Carpenter *in* Dall, 1882. |
| *Chiton loftusianus* King, 1848 | Neoloricata, Cymatochitonidae. Type species of *Cymatochiton* Dall, 1882. |
| *Chiton mempiscus* de Ryckholt, 1845 | Neoloricata, Lepidopleuridae, *Gryphochiton* Gray, 1847*a*. |
| *Chiton mosensis* de Ryckholt, 1845 | Neoloricata, Lepidopleuridae, *Pterochiton*? Carpenter *in* Dall, 1882. |

| Original assignment | Present assignment |
|---|---|
| *Chiton nervicanus* de Ryckholt, 1845 | Neoloricata, Lepidopleuridae. Type species of *Gryphochiton* Gray, 1847*a, b.* |
| *Chiton occidentalis* Foster, 1837 | * |
| *Chiton orbiculus* Trenkner, 1868 | † |
| *Chiton parvus* Stevens, 1858 | Neoloricata, Lepidopleuridae, *Gryphochiton* Gray, 1847*a.* |
| *Chiton priscus* Münster, 1839 | Neoloricata, Lepidopleuridae, *Gryphochiton* Gray, 1847*a.* |
| *Chiton priscus* Sandberger, 1842 | Preoccupied, see *Chiton sandbergianus* de Ryckholt, 1845. |
| *Chiton sagittalis* Sandberger and Sandberger, 1853 | * |
| *Chiton sandbergianus* de Ryckholt, 1845 | Neoloricata, Lepidopleuridae, *Pterochiton* Carpenter *in* Dall, 1882. |
| *Chiton scaldianus* de Ryckholt, 1852 | * |
| *Chiton sluseanus* de Ryckholt, 1845 | Neoloricata, Lepidopleuridae. Synonym of *P. subgemmatus* d'Orbigny, 1850. |
| *Chiton soleaformis* Etheridge, 1882 | Neoloricata, Acutichitonidae, *Soleachiton* Hoare and Smith, 1984. |
| *Chiton subgemmatus* d'Orbigny, 1850 | Neoloricata, Lepidopleuridae, *Pterochiton* Carpenter *in* Dall, 1882. |
| *Chiton subgranosus* Sandberger, 1842 | Nomen nudum. See *Chiton corrugatus* Sandberger and Sandberger, 1856. |
| *Chiton symmetricus* Trenkner, 1868 | Neoloricata, Lepidopleuridae. Synonym of *P. corrugatus* (Sandberger and Sandberger, 1856). |
| *Chiton thomodiensis* Baily, 1859 | Neoloricata, Lepidopleuridae, *Pterochiton* Carpenter *in* Dall, 1882. |
| *Chiton tornaciola* de Ryckholt, 1845 | * |
| *Chiton trapezoidalis* Trenkner, 1868 | † |
| *Chiton tumidus* de Koninck, 1857 | † |
| *Chiton turnacianus* de Ryckholt, 1845 | Neoloricata, Lepidopleuridae, *Gryphochiton* Gray, 1847*a.* |
| *Chiton viseticola* de Ryckholt, 1845 | Neoloricata, Lepidopleuridae, *Gryphochiton* Gray, 1847*a.* |
| *Chiton woodmillensis* Dunlop, 1915 | † |
| *Chiton wrightianus* de Koninck, 1857 | * |
| *Chitonellus bennieanus* Etheridge, 1882 | * |
| *Chitonellus distortus* Kirkby, 1859 | * |
| *Chitonellus hancockianus* Kirkby, 1859 | * |
| *Chitonellus kirkbyanus* Etheridge, 1882 | Neoloricata, Glyptochitonidae, *Glyptochiton* de Koninck, 1883. |
| *Chitonellus*? *patelliformis* Etheridge, 1882 | * |
| *Chitonellus quadratus* Etheridge, 1882 | Neoloricata, Glyptochitonidae, *Glyptochiton* de Koninck, 1883. |
| *Chitonellus*? *subantiquus* Kirkby and Young, 1867 | * |
| *Chitonellus subquadratus* Kirkby and Young, 1867 | Neoloricata, Glyptochitonidae, *Glyptochiton* de Koninck, 1883. |
| *Chitonellus youngianus* Kirkby *in* Young, 1865 | Neoloricata, Glyptochitonidae, *Glyptochiton* de Koninck, 1883. |
| *Cobcrephora corrugata* Bischoff, 1981 | Phosphatoloricata, Cobcrephoridae, genus unchanged. |
| *Cobcrephora silurica* Bischoff, 1981 | Phosphatoloricata, Cobcrephoridae. Type species of *Cobcrephora* Bischoff, 1981. |
| *Cobcrephora* cf. *silurica* Bischoff, 1981 | Phosphatoloricata, Cobcrephoridae, genus unchanged. |
| *Colapterochiton decorus* Hoare and Mapes, 1985*a* | Neoloricata, Lepidopleuridae, genus unchanged. |
| *Coryssochiton parallelus* DeBrock, Hoare, and Mapes, 1984 | Neoloricata, Lepidopleuridae. Type species of *Coryssochiton* DeBrock, Hoare, and Mapes, 1984. |
| *Cymatochiton ryckholtianus* Dall, 1882 | Nomen nudum. Neoloricata, Lepidopleuridae, *Pterochiton* Carpenter *in* Dall, 1882. |
| *Cymatochiton*? *texanus* Girty, 1909 | Neoloricata, Cymatochitonidae, genus unchanged. |
| *Duslia insignis* Jahn, 1893 | * |
| *Elachychiton juxtaterminus* Hoare and Mapes, 1985*a* | Neoloricata, Acutichitonidae, genus unchanged. |
| *Eochelodes bergenhayni* Marek, 1962 | Paleoloricata, Chelodidae. Type species of *Eochelodes* Marek, 1962. |
| *Eochiton arbucklensis* Smith *in* Smith and Toomey, 1964 | Paleoloricata, Gotlandochitonidae. Type species of *Kindbladochiton* Van Belle, 1975*a.* |
| *Euleptochiton torus* Hoare and Mapes, 1985*a* | Neoloricata, Permochitonidae, genus unchanged. |
| *Glaphurochiton simplex* Raymond, 1910 | Neoloricata, Lepidopleuridae, *Gryphochiton* Gray, 1847*a.* |
| *Gotlandochiton birhombivalvis* Bergenhayn, 1955 | Paleoloricata, Gotlandochitonidae, genus unchanged. |
| *Gotlandochiton hami* Smith *in* Smith and Toomey, 1964 | Paleoloricata, Gotlandochitonidae, genus unchanged. |

| Original assignment | Present assignment |
|---|---|
| *Gotlandochiton interplicatus* Bergenhayn, 1955 | Paleoloricata, Gotlandochitonidae. Type species of *Gotlandochiton* Bergenhayn, 1955. |
| *Gotlandochiton laterodepressus* Bergenhayn, 1955 | Paleoloricata, Gotlandochitonidae, genus unchanged. |
| *Gotlandochiton troedssoni* Bergenhayn, 1955 | Paleoloricata, Gotlandochitonidae, genus unchanged. |
| *Gryphochiton triangulatum* Carpenter *in* Dall, 1882 | Neoloricata, Lepidopleuridae, genus unchanged. |
| *Helminthecella expansa* Ulrich and Bridge *in* Butts, 1941 | Paleoloricata, Matthewiidae. Type species of *Helminthecella* Ulrich and Bridge *in* Butts, 1941. |
| *Helminthochiton aequivoca* Robson, 1913 | Neoloricata, Helminthochitonidae, genus unchanged. |
| *Helminthochiton coarctatus* de Koninck, 1883 | Neoloricata, Lepidopleuridae. Synonym of *G. priscus* (Münster, 1839). |
| *Helminthochiton concinnus* Richardson, 1956 | Neoloricata, Lepidopleuridae, *Glaphurochiton* Raymond, 1910. |
| *Helminthochiton girtyi* Hoare and Smith, 1984 | Neoloricata, Lepidopleuridae, *Gryphochiton* Gray, 1847*a*. |
| *Helminthochiton grayiae* Woodward, 1885 | Paleoloricata, Septemchitonidae. Type species of *Septemchiton* Bergenhayn, 1955. |
| *Helminthochiton griffithi* Salter *in* McCoy, 1846 | Neoloricata, Helminthochitonidae. Type species of *Helminthochiton* Salter *in* McCoy, 1846. |
| *Helminthochiton mucronotus* de Koninck, 1883 | Neoloricata, Lepidopleuridae. Synonym of *G. priscus* (Münster, 1839). |
| *Helminthochiton lebescontei* Barrois, 1889 | Neoloricata, Permochitonidae, *Euleptochiton*? Hoare and Mapes, 1985*a*. |
| *Helminthochiton priscoides* Carpenter *in* Dall, 1882 | Neoloricata, Lepidopleuridae, *Gryphochiton* Gray, 1847*a*. |
| *Helminthochiton procumbens* de Koninck, 1883 | Neoloricata, Lepidopleuridae, *Gryphochiton* Gray, 1847*a*. |
| *Helminthochiton riddlei* Frederickson, 1962 | Neoloricata, Lepidopleuridae, *Glaphurochiton*? Raymond, 1910. |
| *Helminthochiton*? *secundus* Horný *in* Špinar 1965 | Neoloricata, Helminthochitonidae, genus unchanged. |
| *Helminthochiton thraivensis* Reed, 1911 | Paleoloricata, Septemchitonidae, *Septemchiton*? Bergenhayn, 1955. |
| *Ivoechiton calathicolus* Smith *in* Smith and Toomey, 1964 | Paleoloricata, Scanochitonidae, genus unchanged. |
| *Ivoechiton oklahomensis* Smith *in* Smith and Toomey, 1964 | Paleoloricata, Scanochitonidae, genus unchanged. |
| *Lekiskochiton fornicis* Hoare and Smith, 1984 | Neoloricata, Lekiskochitonidae. Type species of *Lekiskochiton* Hoare and Smith, 1984. |
| *Lepidopleurus laterodepressus* Bergenhayn, 1945 | Neoloricata, Lepidopleuridae. Type species of *Proleptochiton* Sirenko and Starobogatov, 1977. |
| *Llandeilochiton ashbyi* Bergenhayn, 1955 | * |
| *Luyanhaochiton spinus* Yü, 1984 | Order and family unknown, genus unchanged. |
| *Matthevia variabilis* Walcott, 1885 | Paleoloricata, Matthewiidae. Type species of *Matthevia* Walcott, 1885. |
| *Matthevia walcotti* Runnegar, Pojeta, Taylor, and Collins, 1979 | Paleoloricata, Matthewiidae, genus unchanged. |
| *Ochmazochiton comptus* Hoare and Smith, 1984 | Neoloricata, Heterochitonidae. Type species of *Ochmazochiton* Hoare and Smith, 1984. |
| *Paleochiton kindbladensis* Smith *in* Smith and Toomey, 1964 | Paleoloricata, Gotlandochitonidae. Type species of *Paleochiton* Smith *in* Smith and Toomey, 1964. |
| *Pedanochiton discomptus* DeBrock, Hoare, and Mapes, 1984 | Neoloricata, Cymatochitonidae. Type species of *Pedanochiton* DeBrock, Hoare, and Mapes, 1984. |
| *Permochiton australianus* Iredale and Hull, 1926 | Neoloricata, Permochitonidae. Type species of *Permochiton* Iredale and Hull, 1926. |
| *Pileochiton cancellus* DeBrock, Hoare, and Mapes, 1984 | Neoloricata, Permochitonidae. Type species of *Pileochiton* DeBrock, Hoare, and Mapes, 1984. |
| *Platyceras anomalus* Rowley, 1908 | Neoloricata, Ochmazochitonidae? Type species of *Lobarochiton* Hoare, 1976. |
| *Preacanthochiton cooperi* Bergenhayn, 1960 | Paleoloricata, Preacanthochitonidae. Type species of *Preacanthochiton* Bergenhayn, 1960. |
| *Preacanthochiton* aff. *cooperi* Bergenhayn, 1960 | Paleoloricata, Preacanthochitonidae, genus unchanged. |
| *Preacanthochiton depressus* Bergenhayn, 1960 | Paleoloricata, Preacanthochitonidae, genus unchanged. |
| *Preacanthochiton productus* Bergenhayn, 1960 | Paleoloricata, Preacanthochitonidae, genus unchanged. |
| *Priscochiton*? *mirabilis* Butts, 1926 | Paleoloricata, Matthewiidae, *Chelodes*? Davidson and King, 1874. |
| *Priscochiton*? *sellaeformis* Butts, 1926 | Paleoloricata, Matthewiidae, *Chelodes* Davidson and King, 1874. |
| *Probolaeum*? *canadense* Clarke, 1907 | Paleoloricata, Chelodidae, genus unchanged. |
| *Protalochiton settlensis* Rochebrune, 1883 | Order and family unknown. Type species of *Protalochiton* Rochebrune, 1883. |
| *Pterochiton arthurcooperi* Smith, 1976 | Neoloricata, Lepidopleuridae, genus unchanged. |

| Original assignment | Present assignment |
|---|---|
| *Pterochiton elevatus* Kues, 1978 | Neoloricata, Lepidopleuridae, *Gryphochiton* Gray, 1847*a*. |
| *Pterochiton newelli* Smith, 1976 | Neoloricata, Lepidopleuridae, genus unchanged. |
| *Pterochiton spatulatus* Hoare, Sturgeon, and Hoare, 1972 | Neoloricata, Permochitonidae. Type species of *Euleptochiton* Hoare and Mapes, 1985*a*. |
| *Pterochiton tholus* Hoare, Mapes, and Atwater, 1983 | Neoloricata, Permochitonidae, *Euleptochiton* Hoare and Mapes, 1985*a*. |
| *Rhombichiton acutivalvis* de Koninck, 1883 | Neoloricata, Lepidopleuridae, *Gryphochiton*? Gray, 1847*a*. |
| *Rhombichiton kirkbyi* de Koninck, 1883 | Neoloricata, Cymatochitonidae, *Cymatochiton*? Dall, 1882. |
| *Rhombichiton ochtinensis* Turek and Prokop, 1982 | Neoloricata, Lepidopleuridae, *Proleptochiton* Sirenko and Starobogatov, 1977. |
| *Rhynchoteuthis kaibabensis* Brady, 1955 | Neoloricata, Cymatochitonidae, *Cymatochiton*? Dall, 1882. |
| *Sagmaplaxus sarthacensis* Oehlert, 1881 | Paleoloricata, Chelodidae, *Chelodes*? Davidson and King, 1874. |
| *Septemchiton iowensis* Sanders, 1965 | Paleoloricata, Septemchitonidae, genus unchanged. |
| *Septemchiton vermiformis* Bergenhayn, 1955 | Paleoloricata, Septemchitonidae. Synonym of *S. grayiae* Woodward, 1885. |
| *Soleachiton yochelsoni* Hoare and Smith, 1984 | Neoloricata, Acutichitonidae. Type species of *Soleachiton* Hoare and Smith, 1984. |
| *Solenocaris solenoides* Young and Young, 1868 | Paleoloricata, Septemchitonidae, genus unchanged. |
| *Stegochiton coxi* Hoare and Smith, 1984 | Neoloricata, Lepidopleuridae. Type species of *Stegochiton* Hoare and Smith, 1984. |
| *Stegochiton*? *onerosus* Hoare and Smith, 1984 | Neoloricata, Lepidopleuridae, genus unchanged. |
| *Sulcochiton grayi* de Ryckholt, 1862 | * |
| *Yangtzechiton elongatus* Yü, 1984 | Order and family unknown, genus unchanged. |

* Rejected as a chiton for the purpose of this report.
† Impossible to place systematically.

## Systematic Arrangement

Based on the summary listing, and on some tentative conclusions on systematic placement contained in discussions of individual species in the appended checklist, the following family arrangement for species is offered as a starting point for future students of Paleozoic polyplacophorans. A question mark after a taxon indicates a problematical assignment.

Ever since Lamarck (1802) described the first fossil polyplacophoran, attempts have been made to construct a classification encompassing both fossil and modern forms. In making generic and family assignments herein the following criteria, which are believed to be significant in the phylogeny of the polyplacophorans, have been used. They are listed in approximate order of their importance in the hierarchy of the classification.

1—Composition of the valves.
2—Development of an articulamentum layer.
3—Shape of valves.
4—Shape and extent of the sutural laminae.
5—Development of insertion plates, unslitted and slitted.
6—Development of lateral, central, and posterior valve areas.
7—Ornamentation.

Progressive changes in the sutural laminae, insertion plates, and valve areas should be expected within a family as well as differences in valve shape and ornamentation.

The families Chelodidae in the Paleoloricata and Lepidopleuridae in the Neoloricata are retained, as broadly defined, to encompass taxa which are not assigned to more narrowly defined familial groupings. The Paleozoic polyplacophorans are still so poorly known that the oversplitting at the family level is premature.

## Class POLYPLACOPHORA de Blainville, 1816
## Subclass PALEOLORICATA Bergenhayn, 1955

### Order Chelodina Bergenhayn, 1943
### Family Chelodidae Bergenhayn, 1943

*Eochelodes bergenhayni* Marek, 1962—Middle Ordovician, Czechoslovakia.
*Probolaeum*? *canadense* Clarke, 1907—Lower Devonian, Canada.
*Probolaeum corrugatus* Sandberger and Sandberger, 1856—Middle Devonian, Germany.

### Family Matheviidae Walcott, 1886

*Calceochiton* cf. *C. gibberosus* Flower, 1968—Lower Ordovician, USA (Wisconsin).
*Calceochiton hachitae* Flower, 1968—Lower Ordovician, USA (New Mexico).
*Chelodes bergmani* Davidson and King, 1874—Middle Silurian, Sweden.

*Chelodes bohemicus* (Barrande, 1867)—Upper Silurian, Czechoslovakia.
*Chelodes calceoloides* Etheridge, 1897—Upper Silurian, Australia.
*Chelodes depressus* Bergenhayn, 1960—Lower Ordovician, USA (Missouri).
*Chelodes gibberosus* (Sardeson, 1896)—Lower Ordovician, USA (Minnesota).
*Chelodes gotlandicus* Lindström, 1884—Middle Silurian, Sweden.
*Chelodes intermedius* Bergenhayn, 1960—Lower Ordovician, USA (Virginia).
*Chelodes longissimus* Bergenhayn, 1955—Middle Ordovician, Scotland.
*Chelodes*? *mirabilis* (Butts, 1926)—Lower Ordovician, USA (Alabama).
*Chelodes*? *sarthacensis* (Oehlert, 1881)—Lower Devonian, France.
*Chelodes sellaeformis* (Butts, 1926)—Middle Ordovician, USA (Alabama).
*Chelodes variegatus* Bergenhayn, 1955—Middle Silurian, Sweden.
*Chelodes whitehousei* Runnegar, Pojeta, Taylor, and Collins, 1979—Lower Ordovician, Australia.
*Helmithecella expansa* Ulrich and Bridge *in* Butts, 1941—Lower Ordovician, USA (Missouri).
*Matthevia variabilis* Walcott, 1885—Upper Cambrian, USA (New York).
*Matthevia walcotti* Runnegar, Pojeta, Taylor, and Collins, 1979—Upper Cambrian, USA (Wisconsin).

Family Gotlandochitonidae Bergenhayn, 1955

*Gotlandochiton birhombivalvis* Bergenhayn, 1955—Middle Silurian, Sweden.
*Gotlandochiton hami* Smith *in* Smith and Toomey, 1964—Lower Ordovician, USA (Oklahoma).
*Gotlandochiton interplicatus* Bergenhayn, 1955—Middle Silurian, Sweden.
*Gotlandochiton laterodepressus* Bergenhayn, 1955—Middle Silurian, Sweden.
*Gotlandochiton troedssoni* Bergenhayn, 1955—Middle Silurian, Sweden.
*Kindbladochiton arbucklensis* (Smith *in* Smith and Toomey, 1964)—Lower Ordovician, USA (Oklahoma).
*Paleochiton kindbladensis* Smith *in* Smith and Toomey, 1964—Lower Ordovician, USA (Oklahoma).

Family Preacanthochitonidae Bergenhayn, 1960

*Preacanthochiton cooperi* Bergenhayn, 1960—Upper Cambrian, USA (Missouri).
*Preacanthochiton* aff. *P. cooperi* Bergenhayn, 1960—Upper Cambrian, USA (Missouri).
*Preacanthochiton depressus* Bergenhayn, 1960—Lower Ordovician, USA (Missouri).
*Preacanthochiton productus* Bergenhayn, 1960—Upper Cambrian, USA (Missouri).

Family Scanochitonidae Bergenhayn, 1943

*Ivoechiton calathicolus* Smith *in* Smith and Toomey, 1964—Lower Ordovician, USA (Oklahoma).
*Ivoechiton oklahomensis* Smith *in* Smith and Toomey, 1964—Lower Ordovician, USA (Oklahoma).

Family Septemchitonidae Bergenhayn, 1955

*Septemchiton iowensis* (Sanders, 1962)—Upper Ordovician, USA (Iowa).
*Septemchiton grayiae* (Woodward, 1885)—Middle Ordovician, Scotland.
*Septemchiton*? *thraivensis* (Reed, 1911)—Middle Ordovician, Scotland.
*Solenocaris elongata* (Hadding, 1913)—Upper Ordovician, Sweden.
*Solenocaris solenoides* Young and Young *in* Young, 1868—Upper Ordovician, Scotland.

## Subclass PHOSPHATOLORICATA Bischoff, 1981

Order Phosphatoloricatina Bischoff, 1981
Family Cobcrephoridae Bischoff, 1981

*Cobcrephora corrugata* Bischoff, 1981—Middle Silurian, Australia.
*Cobcrephora silurica* Bischoff, 1981—Upper Ordovician to Late Silurian, Australia.
*Cobcrephora* cf. *silurica* Bischoff, 1981—Lower Silurian, Australia.

## Subclass NEOLORICATA Bergenhayn, 1955

Order Lepidopleurina Thiele, 1910
Family Acutichitonidae Hoare, Mapes, and Atwater, 1983

*Acutichiton allynsmithi* Hoare, Mapes, and Atwater, 1983—Lower Pennsylvanian, USA (Oklahoma).
*Acutichiton etheridgei* n. sp.—Lower Carboniferous, England.
*Acutichiton pannuceus* Hoare and Mapes, 1985*b*—Upper Pennsylvanian, USA (Texas).
*Acutichiton pyrmidalus* Hoare, Sturgeon, and Hoare, 1972—Middle Pennsylvanian, USA (Ohio).
*Arcochiton raymondi* Hoare and Sturgeon, 1976—Middle Pennsylvanian, USA (Ohio).
*Elachychiton juxtatermis* Hoare and Mapes, 1985*a*—Upper Mississippian, USA (Arkansas).
*Soleachiton soleaformis* (Etheridge, 1882)—Lower Carboniferous, Scotland.
*Soleachiton yochelsoni* Hoare and Smith, 1984—Lower and Middle Permian, USA (Texas).

Family Cymatochitonidae Sirenko and Starobogatov, 1977

*Cymatochiton*? *howseanus* (Kirkby, 1857)—Permian, England.
*Cymatochiton*? *kaibabensis* (Brady, 1955)—Middle Permian, USA (Arizona).
*Cymatochiton*? *kirkbyi* (de Koninck, 1883)—Lower Carboniferous, England.
*Cymatochiton loftusianus* (King, 1850)—Upper Permian, England.
*Cymatochiton*? *texanus* Girty, 1909—Middle Permian, USA (Texas).
*Pedanochiton discomptus* DeBrock, Hoare, and Mapes, 1984—Middle Pennsylvanian, USA (Texas).

Family Glyptochitonidae Starobogatov and Sirenko, 1975

*Glyptochiton cordifer* (de Koninck, 1844)—Lower Carboniferous, Belgium.

*Glyptochiton kirkbyanus* (Etheridge, 1882)—Lower Carboniferous, Scotland.
*Glyptochiton quadratus* (Etheridge, 1882)—Lower Carboniferous, Scotland.
*Glyptochiton subquadratus* (Kirkby and Young, 1867)—Carboniferous, Scotland.
*Glyptochiton youngianus* (Kirkby *in* Young, 1865)—Lower Carboniferous, Scotland.

Family Lekiskochitonidae n. fam.

*Lekiskochiton*? *cordatus* (Kirkby, 1859)—Permian, England.
*Lekiskochiton fornicis* Hoare and Smith, 1984—Middle Permian, USA (Texas).

Family Lepidopleuridae Pilsbry, 1892

*Camptochiton squarrosus* DeBrock, Hoare, and Mapes, 1984—Middle Pennsylvanian, USA (Texas).
*Chauliochiton*? *geikei* (Etheridge, 1882)—Lower Carboniferous, Scotland.
*Chauliochiton knighti* Hoare and Smith, 1984—Lower and Middle Permian, USA (Texas).
*Colapterochiton decorus* Hoare and Mapes, 1985*a*—Lower Pennsylvanian, USA (Oklahoma).
*Coryssochiton parallelus* DeBrock, Hoare, and Mapes, 1984—Middle Pennsylvanian, USA (Texas).
*Glaphurochiton carbonarius* (Stevens, 1858)—Middle Pennsylvanian, USA (Illinois).
*Glaphurochiton concinnus* (Richardson, 1956)—Middle Pennsylvanian, USA (Illinois).
*Glaphurochiton*? *riddlei* (Frederickson, 1962)—Upper Pennsylvanian, USA (Oklahoma).
*Gryphochiton*? *acutivalvis* (de Koninck, 1883)—Lower Carboniferous, England.
*Gryphochiton*? *armstrongianus* (Etheridge, 1882)—Carboniferous, Scotland.
*Gryphochiton elevatus* (Kues, 1978)—Middle Mississippian, USA (Indiana).
*Gryphochiton girtyi* (Hoare and Smith, 1984)—Middle Permian, USA (Texas).
*Gryphochiton mempiscus* (de Ryckholt, 1845)—Lower Carboniferous, Belgium.
*Gryphochiton nervicanus* (de Ryckholt, 1845)—Lower Carboniferous, Belgium.
*Gryphochiton parvus* (Stevens, 1858)—Middle Mississippian, USA (Indiana).
*Gryphochiton priscoides* (Carpenter *in* Dall, 1882)—Devonian, Germany.
*Gryphochiton priscus* (Münster, 1839)—Lower Carboniferous, Belgium.
*Gryphochiton procumbens* (de Koninck, 1883)—Lower Carboniferous, Belgium.
*Gryphochiton simplex* (Raymond, 1910)—Middle Pennsylvanian, USA (Pennsylvania).
*Gryphochiton triangulatum* Carpenter *in* Dall, 1882—Lower Carboniferous, Belgium.
*Gryphochiton turnacianus* (de Ryckholt, 1845)—Lower Carboniferous, Belgium.
*Gryphochiton viseticola* (de Ryckholt, 1845)—Lower Carboniferous, Belgium.
*Helminthochiton*? *aequivoca* Robson, 1913—Lower Ordovician, Czechoslovakia.
*Helminthochiton griffithi* Salter *in* McCoy, 1846—Lower Silurian, Ireland.
*Helminthochiton*? *secundus* Horný *in* Špinar, 1965—Devonian, Czechoslovakia.
*Proleptochiton laterodepressus* (Bergenhayn, 1945)—Carboniferous, Scotland.
*Proleptochiton ochtinensis* (Turek and Prokop, 1982)—Upper Carboniferous, Czechoslovakia.
*Pterochiton arthurcooperi* Smith, 1976—Middle Permian, USA (Texas).
*Pterochiton*? *concentricus* (de Koninck, 1844)—Lower Carboniferous, Belgium.
*Pterochiton eburonicus* (de Ryckholt, 1845)—Lower Carboniferous, Belgium.
*Pterochiton legiacus* (de Ryckholt, 1845)—Lower Carboniferous, Belgium.
*Pterochiton*? *mosensis* (de Ryckholt, 1845)—Lower Carboniferous, Belgium.
*Pterochiton newelli* Smith, 1976—Middle Permian, USA (Texas).
*Pterochiton papilio* (Whidborne, 1892)—Devonian, England.
*Pterochiton ryckholtianus* (Dall, 1882)—Lower Carboniferous, Belgium.
*Pterochiton sandbergianus* (de Ryckholt, 1845)—Middle Devonian, Germany.
*Pterochiton subgemmatus* (d'Orbigny, 1850)—Lower Carboniferous, Belgium.
*Pterochiton thomodiensis* (Baily, 1859)—Carboniferous, Ireland.
*Stegochiton coxi* Hoare and Smith, 1984—Lower Permian, USA (Texas).
*Stegochiton*? *onerosus* Hoare and Smith, 1984—Lower Permian, USA (Texas).

Family Heterochitonidae Van Belle, 1978

*Lobarochiton anomalus* (Rowley, 1908)—Upper Devonian, USA (Missouri).
*Ochmazochiton comptus* Hoare and Smith, 1984—Lower and Middle Permian, USA (Texas).

Family Permochitonidae Sirenko and Starobogatov, 1977

*Euleptochiton lebescontei* (Barrois, 1889)—Lower Devonian, France.
*Euleptochiton spatulatus* (Hoare, Sturgeon, and Hoare, 1972)—Middle Pennsylvanian, USA (Ohio).
*Euleptochiton tholus* (Hoare, Mapes, and Atwater, 1983)—Lower Pennsylvanian, USA (Oklahoma).
*Euleptochiton torus* Hoare and Mapes, 1985*a*—Upper Pennsylvanian, USA (Texas).
*Permochiton australianus* Iredale and Hull, 1926—Permian, Australia.
*Pileochiton cancellus* DeBrock, Hoare, and Mapes, 1984—Middle Pennsylvanian, USA (Texas).
*Pileochiton dalriensis* (Etheridge, 1882)—Lower Carboniferous, Scotland.

Order and Family Indeterminate

*Luyanhaochiton spinus* Yü, 1984—Lower Cambrian, China.
*Priscochiton canadensis* (Billings, 1865)—Middle Ordovician, Canada.

*Protalochiton settlensis* Rochebrune, 1883—Lower Carboniferous, England.
*Yangtzechiton elongatus* Yü, 1984—Lower Cambrian, China.

### Family and Genus Indeterminate

"*Chiton*" *burrowianus* Kirkby, 1862—Lower Carboniferous, England.
"*Chiton*" *collinensis* Gortani, 1913—Lower Devonian, Austria.
"*Chiton*" *coloratus* (Kirkby, 1862)—Lower Carboniferous, England.
"*Chiton*" *cordiformis* Sandberger, 1845—Middle Devonian, Germany.
"*Chiton*" *exsectionis* Trenkner, 1868—Upper Devonian, Germany.
"*Chiton*" *gibbosus* Trenkner, 1868—Upper Devonian, Germany.
"*Chiton*" *grayanus* de Koninck, 1857—Lower Silurian, England.
"*Chiton*" *humilis* Kirkby *in* Young, 1865—Carboniferous, Scotland.
"*Chiton*" *inflatus* Trenkner, 1868—Upper Devonian, Germany.
"*Chiton*" *laevigatus* Roemer, 1855—Upper Devonian, Germany.
"*Chiton*" *orbiculus* Trenkner, 1868—Upper Devonian, Germany.
"*Chiton*" *trapezoidalis* Trenkner, 1868—Upper Devonian, Germany.
"*Chiton*" *tumidus* de Koninck, 1857—Upper Devonian, Germany.
"*Chiton*" *woodmillensis* Dunlop, 1915—Lower Carboniferous, Scotland.

## Rejected as Polyplacophora

*Calyptraea antiqua* Howse, 1848—Permian, England.
*Chiton barrandeanus* de Ryckholt, 1852—Lower Carboniferous, Belgium.
*Chiton occidentalis* Foster, 1837—Pennsylvanian, USA (Ohio).
*Chiton sagittalis* Sandberger and Sandberger, 1856—Middle Devonian, Germany.
*Chiton scaldianus* de Ryckholt, 1852—Lower Carboniferous, Belgium.
*Chiton tornaciola* de Ryckholt, 1845—Late Carboniferous, Belgium.
*Chiton wrightianus* de Koninck, 1857—Middle Silurian, England.
*Chitonellus bennieanus* Etheridge, 1882—Lower Carboniferous, Scotland.
*Chitonellus distortus* Kirkby, 1859—Permian, England.
*Chitonellus hancockianus* Kirkby, 1859—Permian, England.
*Chitonellus patelliformis* Etheridge, 1882—Lower Carboniferous, Scotland.
*Chitonellus? subantiquus* Kirkby and Young, 1867—Lower Carboniferous, England.
*Duslia insignis* Jahn, 1893—Lower Silurian, Bohemia.
*Llandeilochiton ashbyi* Bergenhayn, 1955—Middle Ordovician, Scotland.
*Sulcochiton grayi* de Ryckholt, 1862—Lower Carboniferous, Belgium.

### Checklist

*acutivalvis* (de Koninck, 1883), *Gryphochiton*?

*Chiton*? *cordatus* Kirkby and Young, 1867:341, pl. 16, fig. 10, 11a–b [non Etheridge 1882:93–94, pl. 1, figs. 20–22]. Dunlop 1915:169, pl. 22, fig. 6; 1922:75–76.
*Rhombichiton acutivalvis* de Koninck, 1883:210–211, pl. 53, fig. 30–36. New name.

Geological Age.—Lower Carboniferous.
Locality.—England: Lower Scar Limestone, Yorkshire (Kirkby and Young). Eastern Scotland: Woodmill, Fife (Dunlop).
Location of Material.—Collections of J. Bennie, J. Smith, etc. (fide Etheridge). Present location unknown.

Remarks.—*Chiton*? *cordatus*? Kirkby and Young (1867), with good reason, has been confused with *Chiton*? *cordatus* Kirkby (1859). It was found in strata of Lower Carboniferous age whereas *C.*? *cordatus* Kirkby is a Permian species. De Koninck (1883) gave the Carboniferous species a new name, *Rhombichiton acutivalvis,* which was a proper step under the circumstances. It is not clear which species Dunlop (1915) had in mind but presumably he was referring to the one from the Carboniferous. Etheridge (1882) thought "Except in a few trivial points the plates I have represented in Figs. 20–22 do not differ from Kirkby's *Chiton cordatus,* a Permian species."

Kirkby and Young illustrated two valves, a head(?) and an intermediate valve. Etheridge (1882) gave a good description of the Carboniferous valves he studied. His figure 20 shows a broadly triangular tail valve with pointed apex, rather small, pointed sutural laminae, and a distinct, narrow jugal area bordered by granular lateropleural areas. His figure 22 of the ventral side of another tail valve shows an extensive hypotyche area. Dunlop's illustration (1915, pl. 22, fig. 6) is not readily identifiable as a polyplacophoran although it may well be one. Later (1922), Dunlop concluded that *Chiton cordatus, C. armstrongianus,* and *C. gemmatus* from Woodmill, Scotland, were conspecific although his illustration of *C. cordatus* as a head plate only appears different from that of Kirkby and Young.

Until a final determination can be made based on more and better material than seems to have been available, the British Permian and Carboniferous species probably should be separated for taxonomic purposes. Further, Etheridge's (1882) specimens are significantly different from the Permian forms of Kirkby (1859) and those of the

Carboniferous of Kirkby and Young (1867). They are assigned to the genus *Acutichiton* Hoare, Sturgeon, and Hoare (1972) with a new specific name *A. etheridgei* q.v.

### *aequivoca* Robson, 1913, *Helminthochiton*?

*Helminthochiton aequivoca* Robson, 1913:304, fig. 1–3. Horný *in* Špinar, 1965:320.

Geological Age.—Lower Ordovician (Arenigian).

Locality.—Bohemia: Sárka and Malé Prilepy.

Location of Material.—Holotype, BM (N.H.) (fide H. W. Ball).

Remarks.—The valves are subquadrate, minute, strongly carinate along the median line, markedly emarginate posteriorly, and lacking insertion plates and sutural laminae; dorsal sculpture consists of two or three diagonal grooves and numerous fine concentric striae running parallel to the margins. Length, 5.0 mm; height, 3.5 mm.

According to Robson, this species is based on "*Chiton* sp.?" of Professor Kloucek. The valves are badly preserved, consisting of six approximately complete ones and a number of fragments too poor to be of diagnostic value. The better specimens are imprints in portions of two separate ironstone nodules. Robson says Withers (1926) and Reed (1907) think these fossils are amphineuran and not cirripedian; Robson thinks *Helminthochiton aequivoca* is nearest to *H. griffithi* Salter *in* McCoy (1846) and hence refers it to Salter's genus. If, in fact, the valves lack insertional laminae, as indicated by Robson, this would place the species in the Paleoloricata rather than the Neoloricata, and the assignment to *Helminthochiton* is incorrect. The proper generic assignment must depend on further study of the original material in the British Museum.

### *allynsmithi* Hoare, Mapes, and Atwater, 1983, *Acutichiton*

*Acutichiton allynsmithi* Hoare, Mapes, and Atwater, 1983:996–997, fig. 1C, 2A, B, 3A–U, 4A, B, 5N, O.

Geological Age.—Lower Pennsylvanian (Morrowan).

Locality.—USA: Oklahoma, Gene Autry Formation exposed in gullies on east side of unnamed tributary of Sycamore Creek on the Daube Ranch, NW¼ NW¼ SW¼, sec. 2, T 4S, R 4E, Johnson Co.

Location of Material.—Holotype, OSU-34790; paratypes, OSU-34791–34808 and BGSU-4177.

Remarks.—Reconstructed specimens are small, reaching a length of approximately 20 mm and a width of 5 mm giving a length to width ratio of 4:1. Described from a large number of beautifully preserved plates, which allowed the reconstruction of complete individuals, this species is best distinguished by its recurved elongate tail valve. Some intermediate valves show the beginning development of lateral areas.

Average dimensions are (mm):

| | Head | Intermediate | Tail |
|---|---|---|---|
| Length | 1.9 | 4.1 | 3.6 |
| Width | 3.7 | 3.6 | 2.1 |
| Height | 2.1 | 2.7 | 2.0 |

### *anomalus* (Rowley, 1908), *Lobarochiton*

*Platyceras*? *anomalum* Rowley, 1908:90, pl. 19, fig. 15–19.

*Gryphochiton anomalus* (Rowley). Williams 1943:100–101, pl. 9, fig. 19–20.

*Helminthochiton anomalus* (Rowley). Yochelson and Saunders 1967:11.

*Lobarochiton anomalus* (Rowley). Hoare 1976:117–118, fig. 1–3 [type species of *Lobarochiton* Hoare, 1976 by original designation].

*Pterochiton*? *anomalus* (Rowley). Hoare and Sturgeon 1979: 178, pl. 2, fig. 1–3.

Geological Age.—Upper Devonian. (Williams and earlier workers consider this unit Lower Mississippian.)

Locality.—USA: Missouri. "The locality is at the mouth of Buffalo Creek two miles southeast of Louisiana" from washings of the clay seams (Rowley).

Location of Material.—Holotype, UI-RX-75, a tail valve, in the Department of Geology, University of Illinois. Second specimen missing.

Remarks.—The species is based on two cotypes, the length of one being 5.2 mm. Williams believed it was related to *Helminthochiton parvus* (Stevens, 1858), an assignment that now seems incorrect. Rowley's illustrations of his species are much too small for an accurate diagnosis.

Hoare and Sturgeon (1979) illustrated one of Rowley's specimens, a tail valve showing dorsal, ventral, and side views. While this valve is somewhat eroded along the side-margins and at the anterior end, it has a squarish shape with a high, somewhat pointed mucro positioned about one-third the distance from the posterior end. Anterior to the mucro, the valve is sharply concave, dropping down from the mucro almost vertically for a short distance. There is a narrowly triangular jugal area bounded by a pair of shallow grooves or sulci that extend diagonally down from the point of the mucro. There is another pair of shallow grooves that appear to be somewhat

stronger extending down the sides of the valve. The dorsal surface of the valve's posterior area is sculptured with rounded or slightly elliptical pustules of varying sizes and irregular placement. The valve surface forward of the mucro does not show much sculpture although this may be due to wear or abrasion. Ventrally, the anterior margin of the valve shows evidence of the occurrence of sutural laminae. The valve's posterior edge, however, is cut by a series of short, closely spaced slits forming well-defined teeth, of which 40 or more can be counted extending around the entire posterior edge of the valve. This feature is unusual in Paleozoic polyplacophoran species, being only partially approximated in the tail valve of *Glyptochiton cordifer* (de Koninck, 1844) (Smith 1971, fig. 14–15). *Lobarochiton anomalus* (Rowley, 1908) is totally different and not even distantly related to *G. cordifer* although the geological ages of the two species may not be too widely separate as the latter comes from the Carboniferous of Belgium.

Hoare (1976) proposed a new genus *Lobarochiton,* for this unique Paleozoic form. He assigned it to the family Lepidopleuridae irrespective of the presence of insertion plates. *Lobarochiton* is in an uncertain taxonomic position; although for the present it may be tentatively assigned to the Heterochitonidae, Van Belle, 1978.

*antiqua* Howse, 1848. Genus *incertae sedis*

*Calyptraea antiqua* Howse, 1848:242. King 1850:247 (appendix). Howse 1857:464, pl. 4, fig. 16–17; 1858:244, 273, pl. 11, fig. 16–17. Yochelson 1971:130.
*Chitonellus antiquus* (Howse). Kirkby 1859:608, 611, 619–621, pl. 16, fig. 15–23. Baily 1860:94–95 (footnote). Kirkby 1860:254–257, pl. 13, fig. 15–23. Rochebrune 1883:39–40. Etheridge 1882:88–89. Dall 1882:283. Stuckenberg 1898: 163, 346, pl. 3, fig. 25a–b. Branson 1948:760.
*Chiton antiquus* (Howse). Baily 1859:333.

Geological Age.—Permian.
Locality.—England: Tunstall Hill, Durham.
Location of Material.—Type specimen in the Museum of the Geological Survey, Jermyn Street, London (Howse 1858) (now Institute of Geological Sciences and Museum, Exhibition Road). Valves under this name from Gera, Germany, are in the BM (N.H.) (fide H. W. Ball).

Remarks.—Baily (1860) included a footnote to the effect that Kirkby changed the allocation of this species to *Chitonellus,* it "having previously been mistaken by Mr. Howse for a *Calyptraea* . . . ." Dall, Rochebrune, Stuckenberg, and Branson all thought specimens identified as *Chitonellus antiquus* (Howse, 1848) probably were not polyplacophorans.

Kirkby (1859) covered the species in detail based on a total of 10 specimens. His illustrations show rounded valves that are slightly ovate to almost circular in shape, with a sculpture of coarse ribs radiating from a prominent apex, which is generally placed from a slightly to a markedly posterior position. Such a type of sculpture and shape is unusual in Paleozoic polyplacophorans and would appear to have a closer relationship to an ancient patellid gastropod.

The status of the species must remain uncertain pending further study but is not accepted here as a polyplacophoran.

*arbucklensis* (Smith *in* Smith and Toomey, 1964), *Kindbladochiton*

*Eochiton arbucklensis* Smith *in* Smith and Toomey, 1964:26–27, pl. 6, fig. 1–9 [type species of *Eochiton* Smith, 1964, by original designation].
*Kindbladochiton arbucklensis* (Smith). Van Belle 1975*a*:126, pl. 1, fig. 10a–c. Sirenko and Starobogatov 1977:34, fig. 2d.

Geological Age.—Lower Ordovician (Kindblade Formation).
Locality.—USA: Oklahoma; lower part of Kindblade Formation, Mill Creek section, Arbuckle Mts.
Location of Material.—Holotype, OU-5217; paratype, USNM-144540; paratype, CAS-12592.

Remarks.—The species is based on three intermediate valves acid-etched from limestone blocks. No end valves were found. Preservation is relatively poor. The holotype is 8.8 mm long, 11.4 mm wide, and 6.3 mm high. Thickness at the jugum is 3.0 mm. The jugal angle is approximately 106°. It has a well-developed apical area 1.8 mm wide at the apex, increasing to 2.0 mm near the margins.

The name *Eochiton* was first used by Fischer (1885) in a general classification of fossil polyplacophorans as a subgenus of *Holochiton* Fischer, 1885. At the time Smith (1964) introduced *Eochiton* as a genus the name was considered available for subsequent valid use. Van Belle (1975*a*) subsequently proposed a new name, *Kindbladochiton,* which has clarified this taxonomic situation.

*armstrongianus* (Etheridge, 1882), *Gryphochiton*?

*Chiton* sp. Kirkby and Young, 1867:341, pl. 16, fig. 7a–c, 9.
*Chiton armstrongianus* Etheridge, 1882:89–91, pl. 1, fig. 15. Dunlop 1915:169, pl. 22, fig. 2–3; 1922:75–76.

GEOLOGICAL AGE.—Carboniferous.

LOCALITY.—Scotland: Lower and upper limestone of Craigenglen, Williamwood, near Cathcart, Renfrewshire (Kirkby and Young). Williamwood, near Glasgow, in shales of the Orchard Limestone, Upper Carboniferous group; also from Cunningham Baidland, near Dalry, in Lower Carboniferous shale (Etheridge).

LOCATION OF MATERIAL.—Collections of J. Armstrong and J. Bennie (fide Etheridge). Specimens with the label "*Chiton armstrongi* Eth. jun." are in the BM (N.H.) (fide H. W. Ball).

REMARKS.—*Chiton* sp. Kirkby and Young (1867) is based on three tail valves showing well-developed, rounded sutural laminae. Dimensions given are: length, ⅕ inch (5 mm); width, a little less. These authors thought their specimens approached those of *Chiton burrowianus* Kirkby, 1862 quite closely.

Etheridge (1882) gave a good account of this species based on original material cited by Kirkby and Young (1867) and valves collected later. Etheridge said *Chiton armstrongianus* may be distinguished from other species, first by the form of the valves, and second, by the coarseness of the dorsal sculpture, "which resembles, more than anything, the teething of a rasp, or coarse file." In comparing it with *C. humilis* Kirkby *in* Young (1865) Etheridge said *C. armstrongianus* is "more pointed behind, and less acute in front; the impressed concentric grooves less in number; whilst the portion of the plate posterior to the apex is a gradual slope from the latter to the posterior margin, and not nearly as flat as in *C. humilis,* nor nearly equal to the length of the remaining portion of the plate." He also stated that *C. armstrongianus* lacks the short form and the two posterior diagonal ridges of *C. dalriensis* Etheridge, 1882, and he thought it was distinct from *C. gemmatus* de Koninck [=*C. subgemmatus* d'Orbigny, 1850], another coarsely granulate species from the Carboniferous of Belgium.

Dunlop (1915) provided good photographs of what appear to be tail valves from Fife, in eastern Scotland. Later (1922), he said he thought the polyplacophoran fossils from the vicinity of Woodmill, Scotland, identified as *Chiton gemmatus* de Koninck (1842), *C. cordatus* Kirkby, 1859, and *C. armstrongianus* Etheridge, 1882, were referable to a single species.

Without careful study and comparison of available specimens, it would be premature to attempt to assign this material to a described genus and species. *Gryphochiton* Gray, 1847*a* would appear to be a possible generic allocation.

## *arthurcooperi* Smith, 1976, *Pterochiton*

*Pterochiton arthurcooperi* Smith, 1976:281–285, fig. 1–28. Sirenko and Starobogatov 1977:36. Hoare and Smith 1984, fig. 7H–N.

GEOLOGICAL AGE.—Permian.

LOCALITY.—USA: Texas. Type locality: Road Canyon Formation USNM loc. 703-c, Glass Mts., West Texas.

LOCATION OF MATERIAL.—Holotype, USNM-211115; figured paratypes, USNM-221116–221118, 221120–221124, 221132. Valves from 30 other localities in USNM.

REMARKS.—Polyplacophoran of medium to large size when adult, based on a series of extremely well preserved valves acid-etched from limestone blocks collected at or near the boundary between the Leonard and Word formations, Glass Mountain area, and the Cherry Canyon Formation, Guadalupe Series, Guadalupe Mountain area, West Texas. The head valves are somewhat more than semicircular in area; intermediate valves subquadrate, slightly longer than wide, the side-slopes forming an obtuse angle; tail valves elongate-ovate with prominent mucros, posteriorly placed. There are no distinctive sculptural features but the basic microsculpture of the tegmentum consists of extremely fine decussation on all valve areas. Ventrally, the articulamentum lacks insertion plates but the sutural laminae on the intermediate and tail valves are large and well developed.

Measurements of a full-grown head valve and of equivalent intermediate and tail valves are as follows (mm):

| | Head | Intermediate | Tail |
|---|---|---|---|
| Length | 11.2 | 15.9 | 6.8 |
| Width | 12.3 | 13.6 | 5.4 |
| Height | 3.7 | 4.6 | 2.7 |

Most of the valves indicate the length of the animal in life to be 75–100 mm with all valves in place, excluding the girdle. Three unusually large valves have been collected; two of these are intermediate valves measuring 27.5 mm and 23.5 mm respectively; the third is a very large tail valve measuring 25.0 mm long, 23.9 mm wide, and 5.5 mm high. These indicate that at least some animals achieved a total length of 150 mm or more without the girdle.

This West Texas Permian polyplacophoran species belongs in the Neoloricata, suborder Lepidopleurina, family Lepidopleuridae, based on its well-developed articulamentum, its lack of insertion plates, and the weakly-defined shell

areas of dorsal sculpture and configuration. The assignment of this species to the genus *Pterochiton* Carpenter *in* Dall, 1882 is based on the prominent, large-sized sutural laminae and excavated anterolateral margins.

Hoare and Smith (1984) illustrated preserved color markings on intermediate and tail valves of this species.

### *ashbyi* Bergenhayn, 1955. Genus *incertae sedis*

*Llandeilochiton ashbyi* Bergenhayn, 1955:26–27, pl. 1, fig. 14 (type), pl. 2, fig. 12. Smith 1960:170–172, figs. 44,3a–b [ex Bergenhayn].

Geological Age.—Middle Ordovician (Llandeilo, Balclatchie).
Locality.—South Scotland.
Location of Material.—Type, BM (N.H.) 961.

Remarks.—The species is based on a single intermediate valve, which is divided into seven separate shell areas—a most peculiar form for a polyplacophoran. Bergenhayn erected a new family for it (Llandeilochitonidae), the systematic position being uncertain.

So far as known, no additional material has been collected and the status of the species, even as a valid polyplacophoran, seems highly problematical.

### *australianus* Iredale and Hull, 1926, *Permochiton*

*Permochiton australianus* Iredale and Hull, 1926:326, pl. 45 [type species of *Permochiton* Iredale and Hull, 1926, by monotypy]. Iredale and Hull 1927:141, pl. 18. Ashby 1929: 227–228. Cotton and Godfrey 1940:569, 577, fig. 589. Cotton 1964:127, 140, fig. 139. Yochelson 1971: 130, 132. Van Belle 1975*b*:138, pl. 3, fig. 4. Sirenko and Starobogatov 1977: 35.

Geological Age.—Permian (Upper marine series).
Locality.—Australia: Permo-Carboniferous beds of Bunadoon, New South Wales.
Location of Material.—Holotype, a complete cast with two overlying pieces of matrix in Australian Museum, Sydney, Paleontological Section no. F.45764. Plastoholotype of cast in CAS-12817.

Remarks.—A cast of the holotype, but not of the overlying pieces of matrix, was furnished through the courtesy of Dr. H. O. Fletcher of the Australian Museum. The specimen is entire with all eight valves in place and has the general aspect of a Recent species. The valves are gothic-arched with almost straight side-slopes that are sweptwing posteriorly; the jugal ridge is fairly sharp, being only slightly rounded along the median line. The head valve, though present, is not well preserved and is merged with valve *ii* in the fossil state. Intermediate valves appear to have fairly prominent, raised lateral areas and may have been mucronate in a living condition. Neither insertion plates nor sutural laminae are visible on the cast although Iredale and Hull's supposition that they are present in this species is probably correct. The cast of the tail valve has three subtriangular, low, rounded bosses radiating from the center of the posterior margin but this, of course, gives no indication of the external configuration of this valve.

The sculpture of intermediate valve exteriors, based on the available pieces of overlying matrix, is a peculiar ribbed pattern, which is likened by Iredale and Hull to that found on species of *Ischnochiton* or *Lepidopleurus*. This is difficult to infer from the drawings by Joyce K. Allan (*in* Iredale and Hull 1927, pl. 18). Any relationship to *Lepidopleurus* is certainly not indicated.

Measurements of the cast of *Permochiton australianus* are: length, 17.5 mm; width, 10 mm; height, 6 mm. The angle of divergence appears to be a little less than 45°.

Before the cast was available, it was doubtful that this fossil was a polyplacophoran. However, a study of the cast removes this doubt. *Permochiton* has been assigned to the Lepidopleuridae, suborder Cymatochitonina Sirenko and Starobogatov, 1977, and the family Permochitonidae Sirenko and Starobogatov, 1977.

### *barrandeanus* de Ryckholt, 1852. Genus *incertae sedis*

*Chiton barrandeanus* de Ryckholt, 1852:65, fig. 37–38. de Koninck 1883:211. Rochebrune 1883:33.
*Chitonellus barrandeanus* (de Ryckholt). Kirkby 1862:237. Young 1878:324.

Geological Age.—Lower Carboniferous.
Locality.—Belgium: Visé.
Location of Material.—Unknown.

Remarks.—The species is based on a single, heart-shaped valve, asymmetric in outline. De Koninck said it was not a polyplacophoran; Rochebrune believed it to be a species of crinoid. De Ryckholt's illustrations are stylized drawings. The valve has an unusual shape and its assignment to the Polyplacophora probably is incorrect.

*bennieanus* Etheridge, 1882.
Genus *incertae sedis*

*Chitonellus bennieanus* Etheridge, 1882:99–100, pl. 2, fig. 11–13.

GEOLOGICAL AGE.—Lower Carboniferous (Main or Hurlet Limestone).

LOCALITY.—Scotland: Ayrshire, Law Quarry, near Dalry.

LOCATION OF MATERIAL.—Collections of J. Bennie, J. Armstrong, J. Smith, etc. (fide Etheridge). Present location unknown.

REMARKS.—The valves described and illustrated by Etheridge appear quite similar to those of *Chitonellus patelliformis* Etheridge (1882) from the same general locality except for some distortion during fossilization. They are not as markedly asymmetric in shape as *C. distortus* Kirkby, 1859 from the British Permian, however, and are slightly larger in size than valves of *C. patelliformis,* one of them measuring approximately 3 mm long and slightly less in width.

These peculiarly shaped and sculptured valves belong to a group of species described as polyplacophorans and first reported from the British Permian under the name *Calyptraea antiqua* Howse, 1848, and later named *Chitonellus antiquus* by Kirkby (1859). Other related species are mentioned above. Most authors have raised strong doubts that this group of fossils actually are polyplacophorans, having more of the characters of some type of patellid gastropod.

*bergenhayni* Marek, 1962, *Eochelodes*

*Eochelodes bergenhayni* Marek, 1962:373–375, pl. 1, text fig. 1. Van Belle 1975*a*:124, pl. 1, fig. 2. Sirenko and Starobogatov 1977:31.

GEOLOGICAL AGE.—Middle Ordovician (Caradoc).

LOCALITIES.—Europe: central Bohemia (Czechoslovakia). Type locality, Knízkouvice, near Zdice, lower part of the Cernin Beds. Other localities, Zdice and Záluzí near Horovice.

LOCATION OF MATERIAL.—Holotype in the collection of the Geological Survey of Czechoslovakia, Prague; paratypes in the same collection and in the Marek Collection.

REMARKS.—The valves are subtriangular with straight anterior margins and rounded apexes. They are small and apparently rather thin compared with valves assigned to the genus *Chelodes.* The holotype measures: length, 4.6 mm; width, 4.3 mm. The paratypes range in length from 2.4–4.0 mm and in width from 2.5–3.6 mm. Thickness measurements and side-slope angles are not provided. The apical area covers nearly half the length of a valve, ventrally. The illustrations seem adequate except for the lack of side and end views of one or more of the valves.

This species is properly assigned to the order Chelodina. However, the necessity or the desirability of creating a new family for it is doubtful, based on the evidence provided by Dr. Marek. A more conservative approach would be to allow his new genus *Eochelodes* to stand along with *Chelodes* Davidson and King, 1874, in the family Chelodidae.

*bergmani* Davidson and King, 1874, *Chelodes*

*Chelodes bergmani* Davidson and King, 1874:167–168, pl. 18, fig. 14, 14a–c [type species of *Chelodes* Davidson and King, 1874, by original designation]. Lindström 1884:51, pl. 2, fig. 1–8. Fischer 1885:878. Etheridge 1897:68. Bergenhayn, 1943: 298 (as "*bergmanni*"); 1955:12–13, pl. 1, fig. 3a–b, pl. 2, fig. 2 (reconstruction). Smith 1960:I49–I50, fig. 34,5a (reconstruction), 5b–c (type) [ex Bergenhayn 1955]. Van Belle 1975*a*: 123, pl. 1, fig. 1a–b. Sirenko and Starobogatov 1977:31, fig. 1a, b, 2a.

GEOLOGICAL AGE.—Middle Silurian (Gotlandian).

LOCALITIES.—Sweden: Uppermost limestone of Klinteborg; öolite quarry near Gannvik, Grötlingbo (Lindström). Wenlock, Gotland (Etheridge).

LOCATION OF MATERIAL.—Types, RM-6027, 6028. Additional specimens, RM-6025, 6030 (fide Bergenhayn 1955).

REMARKS.—This is the type species of *Chelodes* Davidson and King, 1874 by original designation. Bergenhayn's illustrations of the type show the massive construction of the valves of *Chelodes,* with the extensive apical area as seen from the ventral side, which is as long or longer than half the valve length. The anterior margins of intermediate valves are almost straight, compared with *C. gotlandicus* Lindström, 1884, in which they are strongly emarginated. Also in *C. gotlandicus* the apical area is slightly shorter than half the valve length.

*birhombivalvis* Bergenhayn, 1955, *Gotlandochiton*

*Gotlandochiton birhombivalvis* Bergenhayn, 1955:18–19, pl. 1, fig. 7 (type); pl. 2, fig. 6 (reconstruction). Sirenko and Starobogatov 1977:31.

GEOLOGICAL AGE.—Middle Silurian (Gotlandian).

LOCALITIES.—Sweden: Gotland, at Visby and Kálens Kvarn, Visby.

LOCATION OF MATERIAL.—Holotype, RM-6031. Additional specimens, RM-6423, 6424.

REMARKS.—"This species is differentiated from all previously known paleoloricates by the following combinations of characters: birhombic

form of the intermediate valves, + the extent of the jugal angle, + the complete coverage, + the complete lack of shell areas . . . the species is assigned, with reservations, to the genus *Gotlandochiton* instead of to the genus *Chelodes*. It cannot be assigned to the latter because of the unusual form of the valves and of the complete coverage" (Bergenhayn 1955:19).

Measurements are as follows (mm):

| Specimen no. | Length | Width |
|---|---|---|
| 6031 (Holotype) | 7.4 | 12.5 |
| 6023 | 13.0 | 12.0 |

Bergenhayn calculated the total length of all valves in place to be 48.9 mm for the holotype, and 84.4 mm for valve no. 6023.

### *bohemicus* (Barrande, 1867), *Chelodes*

*Chiton bohemicus* Barrande, 1867:175, pl. 16, fig. 19–28b. Bergenhayn 1930:15.
*Chelodes bohemicus* (Barrande). Lindström 1884:48. Etheridge 1897:68. Bergenhayn 1930:15. Horný *in* Špinar 1965: 319, fig. VIII-8.
*Helminthochiton bohemicus* (Barrande). Robson 1913:304.

Geological Age.—Upper Silurian.
Locality.—Bohemia: Between Bubowitz and Lodenitz.
Location of Material.—Unknown.

Remarks.—There seems little doubt about the correctness of the assignment of this species to the genus *Chelodes* by Lindström in spite of Robson's later assignment of the species to the genus *Helminthochiton*.

### *burrowianus* Kirkby, 1862, "*Chiton*"

*Chiton burrowianus* Kirkby. Baily 1860:95 and footnote; a nomen nudum. Kirkby 1862:234, fig. 1–2. Kirkby and Young 1867:340, pl. 16, fig. 14–15. Rochebrune 1883:35 (as "*burrovianus*").

Geological Age.—Lower Carboniferous (Lower Scar Limestone).
Locality.—England: Settle, Yorkshire, near the base of the Lower Scar subdivision of the Mountain Limestone (Kirkby); Williamswood (Rochebrune).
Location of Material.—Unknown.

Remarks.—Baily (1860) said that J. H. Burrow found the valves of four or five species at Settle, Yorkshire; Kirkby applied the name *burrowianus* to only one of these species. It was described formally by Kirkby (1862).

The species is predicated on both intermediate and tail valves but only a tail valve was adequately figured by Kirkby and Young (1867). Kirkby had "a nearly perfect posterior plate and a fragment of an intermediate plate . . . ." He illustrated the tail valve, which has a semicircular posterior margin and a prominent, narrow mucro; the valve is sharply concave posteriorly. It measures: length, ½ inch (13 mm); breadth, ⅔ inch (17 mm). Both specimens are worn and rather thick-shelled.

Rochebrune doubted that it was a polyplacophoran, believing that it showed the characters of *Bathyurus* Billings, a trilobite.

### *calathicolus* Smith *in* Smith and Toomey, 1964, *Ivoechiton*

*Ivoechiton calathicolus* Smith *in* Smith and Toomey, 1964:24–25, pl. 5, fig. 1–14.

Geological Age.—Lower Ordovician (Kindblade Formation).
Localities.—USA: Oklahoma, type lot from the lower part of the Kindblade Formation, Mill Creek section, Arbuckle Mts.; also from Joins Ranch section, same formation, in a zone of abundant *Calathium*, 485 feet above the base of the Kindblade.
Location of Material.—Holotype, OU-5213; paratypes OU-5214–5216; paratypes, USNM-144536–144539; paratypes, CAS-12589–12591.

Remarks.—The type lot contains ten intermediate valves. No end valves were recovered from acid-etched limestone blocks. Diagnostic characters of the species include a rather blunt jugal ridge, with a pointed, slightly projecting apex, more or less straight side-slopes, semicircular side-margins, a V-shaped posterior edge view compared with an anterior edge view that is U-shaped, a strong ventral thickening, and a well-developed apical area. This species is most closely related to *Ivoechiton oklahomensis* Smith *in* Smith and Toomey, 1964 from the same formation and locality.

### *calceoloides* Etheridge, 1897, *Chelodes*

*Chelodes calceoloides* Etheridge, 1897:67–70, fig. A–F.
*Chelodes? calceoloides* Etheridge. Ashby 1929:227. Iredale and Hull 1926:324; 1927:139. Cotton and Godfrey 1940:569 (as "*Cheloides*"). Cotton 1964:119 (as "*Cheloides*").

Geological Age.—Upper Silurian.
Locality.—Australia: New South Wales, Portion 1 of 635 acres, Parish of Derrengullen, County King (Yass District).
Location of Material.—Australian Museum, Sydney, Paleontological Section, type nos. 46739 and 46740. Plastotypes in CAS-12818, 12818a.

REMARKS.—Although Australian specialists have generally agreed that this species is not a polyplacophoran, or at best a doubtful one, plastotypes of the two valves on which the species is based, supplied through the courtesy of Dr. H. O. Fletcher of the Australian Museum, confirm Etheridge's allocation to the genus *Chelodes.*

From the casts at hand, the two specimens both appear to represent intermediate valves, one (no. 46739) being more broadly alate with a somewhat less pointed apex than the other. In both specimens the jugal ridge is convex (more so in no. 46740) and rounded. The posterior apex of no. 46740 forms a blunt point but is incomplete in no. 46739. Both valves have a rather shallow embayment in the anterior margin, similar but less pronounced than in *Chelodes gotlandicus* Lindström, 1884 from Sweden. No dorsal sculpture or growth ridges are evident in either cast. Measurements of the casts are as follows (mm):

| Item | No. 46739 | No. 46740 |
|---|---|---|
| Length, overall | 33.1+ | 34.8 |
| Length of jugal ridge along median line | 30.5 | 34.6 |
| Length (max.) of apical area | 15.0+ | 13.5 |
| Width (max.) | 25.3 | 21* |
| Height (max.) | 16.4 | 16.5 |
| Thickness (max.) | 10.0 | 9.8 |
| Jugal angle (measured vertically) | 85° | 62° |
| Approx. apical angle (measured horizontally) | 43° | 45° |

* Right anterior margin incomplete on one side.

*Chelodes calceoloides* is by far the largest species in the genus discovered so far. Based on valve no. 46739, the living animal, exclusive of the girdle, would be approximately 201 mm long (almost 8 inches) by Bergenhayn's formula (1955: 11). This is nearly twice the length of *C. bergmani* Davidson and King, 1874 (105 mm) and of *C. gotlandicus* Lindström, 1884 (102 mm). The smallest described member of the genus is *C. sellaeformis* (Butts, 1926), which would have been 56 mm long by the same formula.

### *canadense* Clarke, 1907, *Probolaeum*?

*Probolaeum*? *canadense* Clarke, 1907:194–195, text figs. (unnumbered).

GEOLOGICAL AGE.—Lower Devonian (St. Alban beds).
LOCALITY.—Canada: Cape Rosier Cove, Quebec.
LOCATION OF MATERIAL.—Unknown.

REMARKS.—Clarke thought there was a noteworthy similarity in the form and aspect of his species to *Chiton sagittalis* Sandberger and Sandberger, 1856 from the Middle Devonian of Germany in the Stringocephalen Kalk, which has been rejected as a polyplacophoran herein. *Probolaeum*? *canadense* appears to be a solid polyplacophoran and is probably a paleoloricate.

### *canadensis* (Billings, 1865), *Priscochiton*

*Chiton canadensis* Billings, 1865:394, fig. 37a–c. Rochebrune 1883:19.

*Priscochiton canadensis* (Billings). Dall 1882:281 [type species of *Priscochiton* Dall, 1882, by original designation]. Tryon 1883:339, pl. 85, fig. 64–66. Robson 1913:304. Shimer and Shrock 1944:526, pl. 216, fig. 6–8. Wilson 1951:16, pl. 1, fig. 1–3. Moore, Lalicker, and Fischer 1952:272, fig. 2a–c. Smith 1960:154, fig. 36,10a–c [ex Wilson]. Smith *in* Smith and Toomey 1964:14.

GEOLOGICAL AGE.—Middle Ordovician (Llandeilan).
LOCALITY.—Canada: Ontario–Quebec, in the Black River Limestone, Pauquette Rapids, Ottawa River.
LOCATION OF MATERIAL.—National Museum of Canada, Ottawa.

REMARKS.—This species is based on Billings's original material, no other valves having been reported as collected since. Dall (1882) made it the type species of his genus *Priscochiton,* by original designation.

Although Rochebrune (1883) doubted that *Priscochiton canadensis* was actually a polyplacophoran, guessing it to be more closely related to *Metapoma* (a patellid gastropod), Wilson's (1951) excellent illustrations leave little doubt that the species is a polyplacophoran of a rather unique form. The two known valves appear to represent head valves rather than tail valves as assumed by Billings (1865).

### *cancellus,* DeBrock, Hoare, and Mapes, 1984, *Pileochiton*

*Pileochiton cancellus* DeBrock, Hoare, and Mapes, 1984:1125, fig. 2E, F, 5A–T [type species of *Pileochiton* DeBrock, Hoare, and Mapes, 1984, by original designation].

GEOLOGICAL AGE.—Middle Pennsylvanian (Desmoinesian).
LOCALITY.—USA: Texas, Lazy Bend Formation exposed on a small tributary to Kickapoo Creek, 30 m N of where Farm to Market Road 1189 crosses Rocky Branch, approx. 8.5 km NE of Lipan and 0.75 km S of Kickapoo Falls, Hood Co. Dennis 7½-minute Quadrangle.
LOCATION OF MATERIAL.—Holotype, OSU-36197; paratypes, OSU-35993–36001, 36198–36200 and BGSU-4225.

REMARKS.—A reconstructed specimen has a length to width ratio of approximately 2:1. The head valves are twice as wide as long with a straight or invaginated posterior margin, steep and straight slopes, and a large apical area. The intermediate valves are more than twice as wide as long, subrectangular in shape (apical angle averages 143°), with distinct central and lateral areas, sutural laminae are short and broad, with a large apical area. The tail valves are wider than long, broadly V-shaped in plan view, with steep slopes, mucro located posterior to midlength, jugal sinus sometimes present, and distinct central and posterior areas. Surfaces of the valves are ornamented with large granules arranged in rows except in central areas where ridges paralleling the anterior margin are separated by granules forming a lattice pattern.

Average dimensions are (mm):

| | Head | Intermediate | Tail |
|---|---|---|---|
| Length | 1.6 | 2.7 | 1.6 |
| Width | 4.0 | 5.3 | 2.3 |
| Height | 1.8 | 1.9 | 1.1 |

The new genus *Pileochiton* was erected to include taxa with steep-sloped head valves; intermediate and tail valves with distinct lateral and central areas where the ornamentation is differentiated; and tail valves having a near posterior mucro, being V-shaped, and with short and broad sutural laminae.

### *carbonarius* (Stevens, 1858), *Glaphurochiton*

*Chiton carbonarius* Stevens, 1858:264. Meek and Worthen 1873:608, pl. 29, fig. 15. Collett 1879:327. Whitfield 1882: 96. Kindle 1898:468. Shimer and Shrock 1944:527, pl. 216, fig. 27–34.

*Anthrocochiton carbonarius* (Stevens). Rochebrune 1883: 29–30.

*Glaphurochiton carbonarius* (Stevens). Raymond 1910:153, pl. 26, fig. 6; pl. 28, fig. 15–16 [type species of *Glaphurochiton* Raymond, 1910, by original designation]. Raymond 1911: 88–90, 96, pl. 5, fig. 4. Wanless 1958:21, 39. Yochelson and Saunders 1967:12. Sirenko and Starobogatov 1977:36, fig. 1k–l.

[non] *Pterochiton concinnus* (Richardson, 1956). Hoare, Sturgeon, and Hoare 1972:675.

*Pterochiton carbonarius* (Stevens). Hoare, Sturgeon, and Hoare 1972:677–678, pl. 1, fig. 2–3; pl. 2, fig. 3–6. Hoare 1975: 223–224, fig. 1–3. Hoare and Sturgeon 1979:178–179, pl. 2, fig. 12–13 (not fig. 7–9); pl. 3, fig. 5–6. Hoare, Mapes, and Atwater 1983:999–1000, fig. 5L–M. Kues 1983:19–22, fig. 1.

GEOLOGICAL AGE.—Pennsylvanian.

LOCALITIES.—USA: Illinois, Danville, roof of the Danville coal seam (Stevens); Missouri, St. Louis outlier, Labette Shale Member near top, Henrietta Formation (J. B. Knight, coll., Shimer and Shrock); Pennsylvania, Ames, and Pine Creek limestones, Allegheny Series (Raymond); Ohio, Putnam Hill Limestone and Vanport Limestone units, Lower Allegheny to Middle Conemaugh (Hoare, Sturgeon, and Hoare); Oklahoma, Gene Autry Formation and Texas, Smithwick Formation (Hoare, Mapes, and Atwater).

LOCATION OF MATERIAL.—The whereabouts of Stevens's original specimens are unknown. Examples are in a number of paleontological collections, including the USNM, BM (N.H.), OSU, and BGSU. Hoare (1975) has selected a neotype for *Chiton carbonarius* after a search for type material proved fruitless. This is deposited in the Field Museum of Natural History, Chicago, Illinois, as UC-57331. It is a well-described and illustrated tail valve from or close to the type locality.

REMARKS.—This species seems to be relatively abundant and widespread geographically. Although Raymond (1910) designated it as the type species of a new genus *Glaphurochiton,* and Richardson (1956) placed it in *Helminthochiton,* this species has been placed in the genus *Pterochiton* Carpenter *in* Dall, 1882 by Hoare, Sturgeon, and Hoare (1972), Hoare (1975), Hoare and Sturgeon (1979), and Hoare, Mapes, and Atwater (1983) in recent years. Sirenko and Starobogatov (1977) reassigned it to *Glaphurochiton,* with which we now agree, on the basis of the lack of excavated anterolateral margins on the intermediate and tail valves, more extensive apical areas, narrower and less exposed sutural laminae and the lack of a jugal sinus.

Raymond (1911) reported *Glaphurochiton carbonarius* from Stoops Ferry, Pennsylvania (Pine Creek Limestone), and from Summerhill, Pennsylvania, in a small cut on the Pennsylvania Railroad, 88 miles east of Pittsburgh; he also recorded it at Pittsburgh in a cut on the Brilliant Cutoff of the Pennsylvania Railroad, near the Brilliant pumping station (Ames Limestone).

A beautifully preserved tail valve of *Glaphurochiton carbonarius,* in the collection of the USNM, no. 27750, measures: length, 9.6 mm; width, 8.3 mm; height ca. 4 mm. A 35-mm color slide of this valve is in the CAS Color Slide Series, No. 2298. One of the broadly rounded sutural laminae is well preserved on this specimen, and the irregularly scattered, round to somewhat elongate, pustular, dorsal sculpture, together with at least one rather prominent ridge that parallels the posterior valve margin is well shown. The USNM also contains two separate series of valves from Missouri, near the top of the Labette Shale Member, Henrietta Formation, St. Louis, Mo.

outlier, collected by J. Brooks Knight, which have been correctly identified as "*Chiton*" *carbonarius* by Shimer and Shrock (1944). Several specimens have at least two adjacent valves in place in the matrix; both end and intermediate valves are well represented. The coarse pustulation of *G. carbonarius* shows up well on many of the valves. The following measurements of selected valves from Knight's "Loc. 43 'red'" give a good idea of valve sizes (mm):

| Dimension | Head | Intermediate | Tail |
|---|---|---|---|
| Length | 14.5 | 14.9 | 17.5 |
| Width | 14.5 | 16.3+ | 15.1 |
| Height | 8.0 | 5.2 | 4.0 |

Hoare, Sturgeon, and Hoare (1972) reported extensive collections of valves of this species in Ohio and provided measurements and excellent illustrations of some of them. Also, they furnished valuable new information on the microstructure of the valves and discussed the paleontology of the species (see pp. 676–677). They originally considered *Helminthochiton concinnus* Richardson (1956) to be a synonym, as indicated above, but we now accept it as a distinct species.

### *coarctatus* (de Koninck, 1883)

*Helminthochiton coarctatus* de Koninck, 1883:201–202, pl. 50, fig. 33–36.
See: *priscus* Münster (1839).

Geological Age.—Lower Carboniferous.
Locality.—Belgium: Tournai.
Location of Material.—Location of type specimens unknown. A series of valves is in the USNM-63401.

Remarks.—Specimens in the United States National Museum are labeled: "*Helminthochiton coarctatus,* de Kon./ Carb - Kohlen Kalk / Tournai / Belg." on the reverse side of an original label headed: "Comptoir Belge de Mineralogie & de Paléontologie." They consist of a set of valves presumed to be in positions *i–v,* inclusive, which have been glued in what might be considered as a normally overlapping series; and a similar, continuing series of valves *vi–viii.* All valves are well preserved and complete except for the one presumed to be valve *vi,* which is broken. The head valve is roughly semicircular in shape and measures 13 mm in width and 8.8 mm in length. The intermediate valves are slightly sweptwing in shape and straight-sided with acute jugal ridges terminating in sharply-pointed, slightly mucronate apexes. The divergence of the side-slopes is about 90°. The tail valve is somewhat more than semicircular in dorsal aspect with a well-marked, small, broadly triangular, jugal area terminating in a posteriorly placed, low, pointed mucro. It is 14.4 mm wide and 13 mm long, the point of the mucro being only 2.5 mm from the posterior margin. The jugal area behind the mucro is depressed with a slight upturn toward the posterior end.

None of the valves show any vestiges of microsculpture. All of them are marked with one to three fairly prominent parallel ridges following the configuration of the side margins and, in addition, the tail valve has some curving striations in the depressed area surrounding the point of the mucro. Sutural laminae of the intermediate valves are rather small, rounded and somewhat thickened; the sutural sinuses between them are wide and only slightly curved.

There appear to be hardly any marked specific differences between *Gryphochiton coarctatus* and *G. priscus* (Münster, 1839). Consequently, for the present at least, the former should be treated as a synonym of the latter, well-known species.

### *collinensis* Gortani, 1913, "*Chiton*"

*Chiton collinensis* Gortani, 1913:262, fig. 13a–b.

Geological Age.—Lower Devonian ("Neodevonico inferiore").
Locality.—Austria: Nella Giogaia del Coglians.
Location of Material.—Unknown.

Remarks.—The specimen on which this species is based is elliptical in outline and measures: length, 17 mm; width, 11 mm; and height, 6 mm. The angle of divergence of the side-slopes is 110°. Gortani thought it was a head valve and compared it with the head valve of *Chiton laevigatus* Roemer, 1855 and *Chiton inflatus* Trenkner, 1868 from the Lower Devonian of the Hartz Mts., Germany.

The diagnosis of *Chiton collinensis* is not sufficiently definitive and the illustrations of the valve are too poor even to guess at its systematic position.

### *coloratus* (Kirkby, 1862), "*Chiton*"

*Chiton coloratus* Kirkby, 1862:234–235, fig. 3–6. Kirkby and Young 1867:340, pl. 16, fig. 8a–b. Rochebrune 1883:33.
*Rhombichiton coloratus* (Kirkby). de Koninck 1883:209, pl. 52, fig. 39–42.

Geological Age.—Lower Carboniferous (Lower Scar).

Locality.—England: Yorkshire, in the Mountain Limestone (Kirkby); Settle, Yorkshire (Rochebrune).

Location of Material.—Unknown.

Remarks.—Kirkby based this species on an intermediate and a tail valve. The former measures 0.6 inch (17 mm) long and 0.5 inch (13 mm) wide. It is subquadrate in shape, the side-margins concave and trending inward posteriorly. No mention is made of sutural laminae and Kirkby's illustration does not show any. The color of the dorsal area and the anterior portion is black, following the contour of the margin and the raised dorsal area. The tail valve has much the same aspect as that of *Chiton burrowianus* Kirkby, 1862 from the same locality.

Of interest is Kirkby's remark on coloration. He says: ". . . the color is very evident; the uncolored surface is grey, which is the tint of the matrix. That this is truly the remains of the original color I can scarcely doubt, considering the symmetry observed in its arrangement, which cannot be ascribed to the accidents of fossilization."

Kirkby and Young (1867) mention the collection of a head valve and several tail valves. Rochebrune (1883), whose guesses generally were unreliable, did not believe it was a polyplacophoran.

### *comptus,* Hoare and Smith, 1984, *Ochmazochiton*

*Ochmazochiton comptus* Hoare and Smith, 1984:87–90, fig. 2 (reconstruction), 3A–S [type species of *Ochmazochiton* Hoare and Smith, 1984, by original designation].

Geological Age.—Lower and Middle Permian (Wolfcampian, Leonardian).

Localities.—USA: Texas, Bone Spring Formation, USNM locs. 725c and 725d; Road Canyon Formation, USNM loc. 721j; Cathedral Mountain Formation, USNM loc. 721u, Glass Mts., West Texas.

Location of Material.—Holotype, USNM-330834; paratypes, USNM-330835–330847.

Remarks.—A reconstructed specimen measured approximately 76 mm in length and 40 mm in width with a length to width ratio of 1.9: 1. The head valves are twice as wide as long with an invaginated posterior margin and a short insertion plate marked by grooves and/or rough slits. The intermediate valves are low-arched and swept-winged with a prominent apex (apical angle averages 124°), and much wider than long. The side-slopes and posterior margins are concave and lateral and central areas are distinct. The sutural laminae are short and broad, extending onto the lateral margins as insertion plates, being cut by 3–4 slits. The tail valves are high, wider than long, with an elevated mucro anterior to midlength at the end of a short jugal area. The side-slopes are flat with narrow lateral areas set off from the posterior area by changes in ornamentation. The sutural laminae are not preserved but a short insertion plate is present marked by numerous grooves and/or slits. Ornamentation consists of closely spaced, nodose ridges curving across the central areas and becoming sinuous on the lateral areas.

Average dimensions are (mm):

| | Head | Intermediate | Tail |
|---|---|---|---|
| Length | 8.6 | 8.5 | 6.8 |
| Width | 4.2 | 20.0 | 4.8 |
| Height | 4.6 | 7.2 | 3.5 |

The new genus *Ochmazochiton* and new family Ochmazochitonidae were erected by Hoare and Smith (1984) to include those taxa bearing slitted, but still primitive, insertion plates and having distinct central, lateral, and posterior areas on the valves. Ochmazochitonidae is believed to be a synonym of Heterochitonidae Van Belle, 1978. *Lobarochiton* Hoare, 1976 may belong to this family, although only the tail valve is known.

### *concentricus* (de Koninck, 1844), *Pterochiton*?

*Chiton concentricus* de Koninck, 1844:322–323, pl. 22, fig. 4a–d. de Ryckholt 1845:62. Bronn 1848:291. d'Orbigny 1850, vol. 1:127. de Koninck 1857:195. Baily 1859:333; 1860:95. Rochebrune 1883:31.

*Helminthochiton? concentricus* (de Koninck). Salter 1847:49, 52.

*Rhombichiton concentricus* (de Koninck). de Koninck 1883: 210, pl. 52, fig. 34–38.

*Pterochiton* (*Loricites*) *concentricus* (de Koninck). Dall 1882: 281 [type of the subgenus *Loricites* Carpenter *in* Dall, 1882, by original designation].

*Loricites concentricus* (de Koninck). Tryon 1883:339. Fischer 1957:13.

Geological Age.—Lower Carboniferous.

Locality.—Belgium: Visé.

Location of Material.—Figured type, PSM (de Koninck Collection) (fide P.-H. Fischer). Specimens in BM (N.H.) (fide H. W. Ball).

Remarks.—According to de Koninck (1844) this is a small species, the single intermediate valve collected being not more than 8 mm long,

somewhat reniform in shape, subcarinate along the jugum, the dorsal surface decorated with regularly spaced, concentric sulcations.

Until more study can be given to available specimens of this species, it should probably be left in the genus *Pterochiton* pending a more accurate systematic assignment, should such be deemed necessary.

### *concinnus* (Richardson, 1956), *Glaphurochiton*

*Helminthochiton concinnus* Richardson, 1956:62, fig. 34–36. Smith 1960:I48, fig. 33,1a–c (ex Richardson). Yochelson and Saunders 1967:12.

*Pterochiton concinnus* (Richardson). Hoare, Sturgeon, and Hoare 1972:675. Yochelson and Richardson 1979:321–331, fig. 1–5.

*Glaphurochiton concinnus* (Richardson). Sirenko and Starobogatov 1977:36.

GEOLOGICAL AGE.—Middle Pennsylvanian (Desmoinesian).

LOCALITY.—USA: Illinois, Francis Creek Shale, Mazon Creek area, near Coal City.

LOCATION OF MATERIAL.—Holotype, 3000-1.1 in the private collection of Mr. and Mrs. John M. McLuckie, Coal City, Illinois (fide Richardson). Plastotypes and additional specimens (PE 31877–31878, 31904, 31946–31947), are in the repositories of the Field Museum of Natural History and in Princeton University.

REMARKS.—This species is based on remarkably well preserved specimens preserved in ironstone concretions. Many specimens have all eight valves in place with an impression of the radula below valves *i* and *ii,* making them unique in the fossil polyplacophoran record (Richardson 1956, fig. 34, 36; Hoare and Sturgeon 1979, pl. 2, fig. 7–9; Yochelson and Richardson 1979, fig. 1–4). In other specimens, well-developed sutural laminae and the granular sculpture of the tegmentum, which is characteristic of the genus *Glaphurochiton,* is beautifully preserved. Yochelson and Richardson (1979) describe and illustrate the outline of the girdle and the distribution of the spicules (fig. 3, 5).

Richardson says *Glaphurochiton concinnus* is half the size of *G. carbonarius* (Stevens, 1858), a fossil species of approximately the same age from Danville, Illinois. Hoare, Sturgeon, and Hoare (1972:675) considered *G. concinnus* to be a junior synonym of *G. carbonarius.* A comparison of latex casts of *G. concinnus* with *G. carbonarius* indicates that the two species are distinct with a finer ornamentation on the former species as well as a more rounded margin on the tail valve. The assignment to *Glaphurochiton* Raymond, 1910 is on the same basis as discussed under *G. carbonarius.*

### *cooperi* Bergenhayn, 1960, *Preacanthochiton*

*Preacanthochiton cooperi* Bergenhayn, 1955:39 (nomen nudum); 1960:169–173, fig. 1–3 [type-species of *Preacanthochiton* Bergenhayn, 1960, by original designation]. Smith *in* Smith and Toomey 1964:15. Runnegar and Pojeta 1974: 312–313. Runnegar, Pojeta, Taylor, and Collins 1979:1391–1392, pl. 2, fig. 62–66.

GEOLOGICAL AGE.—Upper Cambrian (Eminence Dolomite). Lower Ordovician (Gasconade Formation).

LOCALITIES.—USA: Missouri, Shannon, Washington, and Crawford counties (Upper Cambrian); Reynolds and Madison counties (Lower Ordovician). Locality details are provided by Bergenhayn (1960:169).

LOCATION OF MATERIAL.—Holotype, USNM-137370. A total of 38 specimens from the Upper Cambrian and four from the Lower Ordovician are also in the USNM.

REMARKS.—The species is based on presumed head, tail, and intermediate valves, which are of small size. Bergenhayn estimated that the holotype was a polyplacophoran about 31 mm long, exclusive of the girdle, its length being about seven times its width. Another specimen is estimated to have been about 38 mm long. A new family, Preacanthochitonidae, as well as a new genus is erected for *Preacanthochiton cooperi* and for another species, *P. depressus,* described at the same time.

Following a critical examination of the holotype and related specimens Smith was unable to confirm the fact that the fossils represented polyplacophorans, appearing to be more patellid in aspect. Runnegar and Pojeta (1974) said: ". . . *Preacanthochiton* appears to be closely related to the Early Ordovician genus *Chelodes* Davidson and King." Later, Runnegar et al. (1979) redescribed and illustrated the type specimens, accepting them as part of the earliest polyplacophoran faunas from the Late Cambrian.

Therefore, the family Preacanthochitonidae, the genus *Preacanthochiton,* and the species *P. cooperi* and *P. depressus* are being accepted as valid constituents of the Paleozoic polyplacophoran fauna for the purpose of this report.

### aff. *cooperi* Bergenhayn, 1960, *Preacanthochiton*

*Preacanthochiton* aff. *cooperi* Bergenhayn, 1960:173–174, fig. 9–10.

GEOLOGICAL AGE.—Upper Cambrian (Eminence Dolomite).

LOCALITIES.—USA: Missouri, Shannon and Franklin counties.

LOCATION OF MATERIAL.—Hypotype, USNM-137374.

REMARKS.—The fossils consist of a cast of a tail valve and three other presumed tail valves from several field localities.

The comments on related specimens of *Preacanthochiton cooperi* Bergenhayn (1960) apply to these specimens also.

## *cordatus* (Kirkby, 1859), *Lekiskochiton*?

*Chiton*? *cordatus* Kirkby, 1859:616–617, pl. 16, fig. 24–27, 54–55. Baily 1859:333; 1860:95. Kirkby 1860:250–252, pl. 13, fig. 24–27. Geinitz 1861:55, fig. VII-10, 11. Kirkby and Young 1867:341, pl. 16, fig. 10, 11a–b. Dall 1882:283. Lindström 1884:49. Branson 1948:760. Yochelson 1971:130.

*Chitonellus cordatus* (Kirkby). Rochebrune 1883:40–41.

GEOLOGICAL AGE.—Permian.

LOCALITY.—England: Durham. Found rarely in the shell limestone of Tunstall Hill (Kirkby). Upper Zechstein magnesian limestone (Rochebrune).

LOCATION OF MATERIAL.—Unknown.

REMARKS.—From Kirkby's illustrations it is difficult to tell whether the fossils represent polyplacophorans or not, although some have a polyplacophoran aspect. Geinitz, Dall, Rochebrune, Lindström, and Branson all thought these fossils were doubtful polyplacophorans. The so-called valves are small, not being more than 3–4 mm in length and width. Kirkby's figures 24 and 27, which he thought were tail valves, have questionable polyplacophoran aspects and do not appear to represent the same species as his figures 25–26, said to be intermediate valves, which do appear polyplacophoran. Figures 54 and 55 are considered to be a head valve, which also seems polyplacophoran. If *Chiton cordatus* is based upon the plates illustrated in figures 25–26 the species can be accepted as a valid polyplacophoran and can be tentatively assigned to the genus *Lekiskochiton* Hoare and Smith (1984:93) from the Permian of West Texas.

*Lekiskochiton*? *cordatus* (Kirkby, 1859), a Permian species, is not *Chiton*? *cordatus* Kirkby and Young, 1867 from the Carboniferous Lower Scar Limestone of Yorkshire, England. The discussion under this species name by Etheridge (1882) refers to valves from the Carboniferous which are different than the Carboniferous valves of Kirkby and Young (1867) which were renamed *Rhombichiton acutivalvis* de Koninck, 1883, q.v.

## *cordatus* (Kirkby and Young, 1867)

*Chiton*? *cordatus*? Kirkby and Young, 1867:341, pl. 16, fig. 10, 11a–b.

See: *acutivalvis* de Koninck, 1883.

## *cordifer* (de Koninck, 1844), *Glyptochiton*

*Chiton*? *cordifer* de Koninck, 1844:324, pl. 22, fig. 5a–b. de Ryckholt 1845:60, pl. 4, fig. 9–16. Salter 1847:49. Bronn 1848:291. Bigsby 1878:319. Dall 1882:283. Rochebrune 1883:31–32.

*Chiton* (*Chitonellus*) *cordifer* de Koninck. de Koninck 1857: 196 (as "*condifer*"). Baily 1859:333; 1860:170.

*Chitonellus cordifer* (de Koninck). d'Orbigny 1850, vol. 1:127. Kirkby 1862:237 (footnote). Etheridge 1882:97.

*Glyptochiton cordifer* (de Koninck). de Koninck 1883:213 [type species of *Glyptochiton* de Koninck, by original designation]. Quenstedt 1932:95–96. Fischer 1957:12. Smith 1960:172, fig. 44,5a–c [ex de Koninck 1883]; 1971:567–572, fig. 1–15 (on 2 pls.). Van Belle 1975*b*:143, pl. 2, fig. 3a–c. Sirenko and Starobogatov 1977:37.

GEOLOGICAL AGE.—Lower Carboniferous.

LOCALITY.—Belgium: Tournai.

LOCATION OF MATERIAL.—Four specimens, PSM (de Koninck Collection) (fide P.-H. Fischer); BM (N.H.) (fide H. W. Ball). USNM-63404 (six specimens: head, tail, and four intermediate valves).

REMARKS.—The intermediate valves are elongate, with deep sinuses at both ends and a heart-shaped or teardrop-shaped tegmentum. They are unlike the fossil valves of any other genus of Paleozoic or Mesozoic polyplacophorans so far described. Other representatives of the genus *Glyptochiton* are *G. youngianus* Kirkby *in* Young, 1865 and *G. subquadratus* Kirkby and Young, 1867. The early illustrations of *Glyptochiton* species are highly stylized drawings. Better illustrations of specimens in the USNM were supplied by Smith (1971); these show the presence of a well-developed pectinated insertion plate on the tail valve and pectination of the ventral surface under the tegmentum layer at the posterior sinus.

Earlier paleontologists had considerable doubt whether *Glyptochiton cordifer* was, in fact, a polyplacophoran. De Ryckholt thought it might be a crinoid plate and so did Rochebrune and Dall. According to Salter (1847), even de Koninck admitted that it might be an "encrinital plate," although he considered it to be polyplacophoran in 1883 when he established the genus *Glyptochiton* for it.

There now seems little doubt that *Glyptochiton* is a polyplacophoran of an unusual kind. The tegmentum of the valves is similar to that in the

Recent genus *Amicula* in which the valves are buried deeply in its thick, muscular girdle with only a small area of heart-shaped tegmentum exposed. The valves of the Recent genus *Choriplax* are somewhat similar in this respect.

Starobogatov and Sirenko (1975) proposed a new suborder Choriplacina and a new family Glyptochitonidae for the genus *Glyptochiton.*

### *cordiformis* Sandberger, 1845, "*Chiton*"

*Chiton cordiformis* Sandberger, 1845:439. Bronn 1848:291. Pictet 1855:300. de Koninck 1857:192, 196. Baily 1859:333. Baily 1860:92, 95. Rochebrune 1883:23. de Koninck 1883: 199.

Geological Age.—Middle Devonian.

Locality.—Germany: Vilmar, in Prussia (Hesse-Nassau) (Sandberger); Grund, Hartz Mts. (Roemer).

Location of Material.—Unknown.

Remarks.—This species name was introduced by Fridolin Sandberger, Guido Sandberger's younger brother, for specimens identified and illustrated as *Bellerophon expansus* Sowerby, 1839 by Roemer (1843:32, pl. 9, fig. 5). Bronn (1848) listed *B. expansus* as a synonym of *Chiton cordiformis* probably based on Roemer's material. Pictet (1855) expressed the view that these fossils were polyplacophoran plates, at the same time pointing out the possibility of confusion between polyplacophoran tail valves and the shells of *Metapoma,* a patellid gastropod. De Koninck (1857) and Baily (1860) listed *C. cordiformis* under a single species number along with *Chiton corrugatus* Sandberger and Sandberger (1856), *C. priscus* Sandberger (1842) [non Münster, 1839], and *C. sandbergianus* de Ryckholt, 1845, evidently considering the three conspecific. Referring to *C. subgranosus* and *C. fasciatus,* both of Sandberger (1842), de Koninck said that "one of these species is probably identical with that which Roemer has mistaken for *Bellerophon expansus* Sow." He did not specify which one, however. To further complicate the synonymy of *C. cordiformis* it should be noted that Clarke (1885) placed it under *C. laevigatus* Roemer, 1855. Both *C. subgranosus* and *C. fasciatus* were nomina nuda at the time the names were introduced; both names were dropped and replaced by *C. corrugatus* and *C. sagittalis* by the Sandbergers in 1856. Thus the validity of *C. cordiformis* and its relationship to other species from the Devonian of Vilmar remains in doubt.

Roemer's illustration of "*Bellerophon*" *expansus* shows an intermediate valve of swept-wing shape with a deep anterior sinus and no sutural laminae or insertion plates. This is the only specimen, apparently. Roemer's identification as a *Bellerophon* is manifestly incorrect. If it can be established that *Chiton cordiformis* has no articulamentum shell layer, it belongs in the suborder Chelodina. The taxonomic status of this species can be determined only by a further study and comparison of type and related specimens with other species from the Devonian of Vilmar.

### *corrugata* Bischoff, 1981, *Cobcrephora*

*Cobcrephora corrugata* Bischoff, 1981:192–193, pl. 2, fig. 31–33.

Geological Age.—Middle Silurian.

Localities.—Australia. Quarry Creek Limestone (type section) on south bank of Quarry Creek, about 21 km west of Orange, New South Wales. Boree Creek Formation, 1 km west of Borenore Caves, approximately 22 km west northwest of Orange, New South Wales.

Location of Material.—Holotype (SMF-34370) and paratypes (also listed as SMF-34370) deposited in the Senckenberg Museum, Frankfurt am Main, Republic of West Germany.

Remarks.—Valves of alternating lamellae of organic and apatitic material. Tail and head valves unknown. Intermediate valves similar to *Cobcrephora silurica* Bischoff, 1981 but differ by having more pronounced jugal ridges separating a deeper trough with well-developed transverse ridges on the lateropleural areas.

### *corrugatus* (Sandberger and Sandberger, 1856), *Probolaeum*

*Chiton subgranosus* Sandberger, 1842:399 (nomen nudum). de Ryckholt 1845:62. Salter 1847:49, 51 (footnote). Bronn 1848: 292. de Koninck 1857:192 (and footnote). Baily 1859:333; 1860:92 (and footnote).

*Chiton corrugatus* Sandberger and Sandberger, 1856:238–239, pl. 26, fig. 22, 22a–d [non Reeve (1848), a Recent species]. de Koninck 1857:192 (and footnote), 196. Baily 1859:333; 1860:92 (footnote), 95. Trenkner 1868:136–137, pl. 2, fig. 29. Dall 1882:283 (for Sandberger and Sandberger 1856, pl. 26, fig. 22a only). Clarke 1885:338–339.

*Chiton symmetricus* Trenkner, 1868:137, pl. 2, fig. 30 [fide Clarke 1885].

*Gryphochiton corrugatus* (Sandberger and Sandberger). Rochebrune 1883:21–22.

*Probolaeum corrugatum* (Sandberger and Sandberger). Dall 1882:281–282 [type species of *Probolaeum* Carpenter, in part, *Chiton corrugatus* Sandberger and Sandberger, by original designation]. Tryon 1883:339. Smith 1960:I54, fig. 36,8 [ex Sandberger and Sandberger].

Geological Age.—Devonian, in Stringocephalen Kalk (Sandberger and Sandberger). Middle Devonian (Rochebrune). Devonian and Lower Devonian (Dall).

LOCALITY.—Germany: Vilmar, in Prussia (Hesse-Nassau) (12.9 km SW of Weilberg on modern maps) (Sandberger and Sandberger); Ehrenbreitstein (Dall).

LOCATION AND MATERIAL.—Location of type specimens unknown. The Sandbergers (1856) stated that the finest specimens were in the Weisbaden Museum. Specimens from Winterberg, Germany in BM (N.H.) (fide H. W. Ball).

REMARKS.—This species was first listed in 1842, but not described, as *Chiton subgranosus,* a name that was dropped for no apparent reason and subsequently described and illustrated as *Chiton corrugatus* by the Sandbergers in 1856. De Koninck and Baily considered *C. corrugatus, C. cordiformis* Sandberger, 1845, *C. priscus* Sandberger, 1842 (non Münster, 1839), and *C. sandbergianus* de Ryckholt, 1845 to be conspecific and grouped them under a single number in their species lists. Rochebrune treated *C. subgranosus* Sandberger, 1842, *C. priscus* Sandberger, 1842, and *C. sandbergianus* de Ryckholt, 1845 as synonyms of *C. corrugatus.* Clarke included *C. symmetricus* Trenkner, 1868 and *C. trapezoidalis* Trenkner, 1868 as additional synonyms.

In making *Chiton corrugatus* the type species of *Probolaeum* Carpenter *in* Dall, 1882, Dall based it on the single specimen illustrated by the Sandbergers (1856) in their plate 26, figure 22a. Dall said that the Sandbergers' other specimens were not chitons. He also said that "among Recent forms this species comes nearest to *Katharina tunicata,* but the difference is still extremely great."

Thus, *Probolaeum corrugatum,* based on a single fossil valve, rests on rather slim evidence for its validity. There seems no other course to follow than to retain Dall's generic assignment pending further study of Devonian polyplacophorans from Vilmar, Germany.

### *coxi,* Hoare and Smith, 1984, *Stegochiton*

*Stegochiton coxi* Hoare and Smith, 1984:99, fig. 10A–I [type species of *Stegochiton* Hoare and Smith, 1984, by original designation].

GEOLOGICAL AGE.—Lower Permian (Wolfcampian).

LOCALITIES.—USA: Texas, Skinner Ranch Formation, USNM loc. 720g; Bone Spring Formation, USNM loc. 725d, Glass Mts., West Texas.

LOCATION OF MATERIAL.—Holotype, USNM-330887; paratypes, USNM-330892, 330893.

REMARKS.—Head and tail valves unknown. The species is based upon two intermediate valves which are highly arched (jugal angle averaging 95°) and vaulted. The jugal area projects anteriorly as a false beak. The jugum is broadly rounded with central areas slightly convex and lateral areas composed of broad, raised, flat-topped ridges. The sutural laminae are large and subtriangular in shape. The surface ornamentation consists of coarse, closely spaced beaded ridges draped across the lateral area and swinging diagonally across the central area.

Average dimensions of the intermediate valves are: length, 7.3 mm; width, 11.8 mm; height, 6.0 mm.

The new genus *Stegochiton* was erected by Hoare and Smith (1984) to include forms with the combination of broadly rounded jugum extending as a false beak; vaulted, distinct lateral and central areas; broad triangular shape; and large sutural laminae. This genus may also contain *S.? onerosus* Hoare and Smith, 1984 and appears to be related to *Proleptochiton* Sirenko and Starobogatov, 1977.

### *dalriensis* (Etheridge, 1882), *Pileochiton*

*Chiton dalriensis* Etheridge, 1882:86–89, pl. 1, fig. 1–14.

GEOLOGICAL AGE.—Lower Carboniferous (Main or Hurlet Limestone).

LOCALITY.—Scotland: Ayrshire, from the Law Quarry near Dalry (Etheridge).

LOCATION OF MATERIAL.—Collections of J. Bennie, J. Armstrong, J. Smith, and others (fide Etheridge). Present locations unknown.

REMARKS.—This species is based, apparently, on a fair-sized series of specimens in which intermediate, head, and tail valves are represented. They are described and discussed in considerable detail, and are unusually well illustrated. The configuration of the valves, the granulate sculpture, and the well-developed sutural laminae all argue for placing the species in the genus *Pileochiton* DeBrock, Hoare, and Mapes, 1984. According to Etheridge, there is a close analogy between *Chiton dalriensis* and the Permian *C. loftusianus* King, 1850, but it differs from the latter in several important particulars in addition to being smaller in size.

### *decorus* Hoare and Mapes, 1985*a*, *Colapterochiton*

*Colapterochiton decorus* Hoare and Mapes, 1985*a*:878, fig. 2.

GEOLOGICAL AGE.—Lower Pennsylvanian (Morrowan).

LOCALITY.—USA: Oklahoma, Gene Autry Formation exposed in gullies on east side of unnamed tributary of Sycamore

Creek on the Daube Ranch, NW¼ NW¼ SW¼, sec. 2, T 4S, R 4E, Johnson Co. Rochelle 7½-minute Quadrangle.

LOCATION OF MATERIAL.—Holotype, OSU-36992; paratypes, OSU-36993–36998; BGSU-4447.

REMARKS.—Reconstructed specimens are medium-sized, about 55 mm long and ornamented with coarse granules and growth lamellae. The sutural laminae are narrow and bluntly pointed. The intermediate valves are swept forward with a large jugal sinus. The subpentagonal tail valve has a mucro posterior to midlength and arched posterior margin. Hoare and Mapes (1985*a*) mistakenly stated reconstructed length as 5.5 mm.

Dimensions are (mm):

| | Head | Intermediate | Tail |
|---|---|---|---|
| Length | 2.6 | 7.1 | 11.0 |
| Width | 4.0 | 10.4 | 12.0 |
| Height | 1.8 | 3.5 | 4.3 |

### *depressus* Bergenhayn, 1960, *Chelodes*

*Chelodes depressus* Bergenhayn, 1960:175, fig. 15–16. Smith *in* Smith and Toomey 1964:15. Sirenko and Starobogatov 1977:31.

GEOLOGICAL AGE.—Lower Ordovician (Gasconade Formation and Longview Formation).

LOCALITIES.—USA: Virginia, 4.8 km NW of Middletown, Longview Formation, 1,000 feet below the *Ceratopea* zone (USGS locality 2464-Co); Missouri, 16.9 km SW of St. Clair, Franklin County (USGS locality 438-t), Gasconade Formation, 4 km above the mouth of Little Indian Creek on the Merrimac River (type locality).

LOCATION OF MATERIAL.—Holotype, USNM-137376. Additional specimens in USNM.

REMARKS.—This species is based on one weathered intermediate valve and a well-preserved tail valve from the type locality in Missouri, and three intermediate valves from Virginia. The assignment to the genus *Chelodes* seems proper.

### *depressus* Bergenhayn, 1960, *Preacanthochiton*

*Preacanthochiton depressus* Bergenhayn, 1960:173, fig. 4–6.

GEOLOGICAL AGE.—Lower Ordovician (Gasconade Formation).

LOCALITY.—USA: Missouri, Hahatonka Springs, 2 km N of Decaturville, Camden County (Gasconade Formation); on top of hill on the Ellington Road, 4 km S of Centerville, Reynolds County (Gasconade Formation).

LOCATION OF MATERIAL.—Holotype, USNM-137372. Additional specimens in USNM.

REMARKS.—The basis for this species is an intermediate valve (the holotype), an impression of the dorsal side of the same valve, and a tail valve. Measurements of these are not given but Bergenhayn estimated a total length, excluding the girdle, of about 28 mm, and a length to width ratio of 8. This would be a relatively elongate polyplacophoran of small size.

A brief examination of these fossils by Smith led to the suspicion that they may not be polyplacophorans. More and better material is needed to determine the exact status of the species. The comments found under *Preacanthochiton cooperi* Bergenhayn, 1960 apply as well to *P. depressus.*

### *discomptus,* DeBrock, Hoare, and Mapes, 1984, *Pedanochiton*

*Pedanochiton discomptus* DeBrock, Hoare, and Mapes, 1984: 1123, fig. 2C, D, 4A–Z, AA, BB [type species of *Pedanochiton* DeBrock, Hoare, and Mapes, 1984, by original designation].

GEOLOGICAL AGE.—Middle Pennsylvanian (Desmoinesian).

LOCALITY.—USA: Texas, Lazy Bend Formation exposed on a small tributary to Kickapoo Creek, 30 m N of where Farm to Market Road 1189 crosses Rocky Branch, approx. 8.5 km NE of Lipan and 0.75 km S of Kickapoo Falls, Hood Co., Texas. Dennis 7½-minute Quadrangle.

LOCATION OF MATERIAL.—Holotype, OSU-35974; paratypes, OSU-35975–35992, 36195–36196 and BGSU-4224.

REMARKS.—A reconstructed specimen is about 23 mm long and 9 mm wide. The head valves are twice as wide as long with straight to invaginated posterior margin and slopes straight to gently concave. The intermediate valves are nearly three times wider than long, high-arched (jugal angle averages 124°), slightly mucronate, with squared lateral margins, and short and broad sutural laminae extending to the anterolateral corner. The tail valves have broadly rounded posterior and lateral margins with a sharp anterolateral corner, a mucro located just anterior to midlength, usually concave side and posterior slopes ending in flattened margins, and short and broad sutural laminae. The valve surfaces are ornamented with fine granules arranged in a quincunx pattern.

Average dimensions are (mm):

| | Head | Intermediate | Tail |
|---|---|---|---|
| Length | 3.0 | 2.2 | 2.8 |
| Width | 6.9 | 6.9 | 5.2 |
| Height | 3.2 | 2.3 | 1.4 |

The new genus *Pedanochiton* was erected to include taxa with exceptionally short, subrectan-

gular intermediate valves with short and broad sutural laminae extending to the anterolateral corners and semicircular tail valves.

### *distortus* Kirkby, 1859. Genus *Incertae sedis*

*Chitonellus distortus* Kirkby, 1859:623–624, fig. 28–30. Baily 1860:95. Kirkby 1860:260–262, pl. 13, fig. 28–30. Geinitz 1861:56. Dall 1882:283. Rochebrune 1883:41. Branson 1948: 761. Yochelson 1971:131.
*Chiton distortus* (Kirkby). Baily 1859:333.

Geological Age.—Permian.
Locality.—England: Tunstall and Humbleton Hills, Durham (Kirkby); Settle, Yorkshire (Rochebrune).
Location of Material.—Unknown.

Remarks.—Kirkby based his species on three specimens only, which are quite small in size. His three illustrations show fossils quite unpolyplacophoran in character, particularly with respect to the configuration of the insertion plates and especially of the sutural laminae, which are definitely not like any species in the Neoloricata, even allowing for considerable distortion during fossilization. Dall (1882:283) listed it, with others, that "have been found not to be chitons or chitonoid." Rochebrune listed it as a "*sp. incertae.*" Both Geinitz and Branson stated it was not a polyplacophoran.

On the basis of the above evidence, pending further study of the type material, *Chiton distortus* Kirkby, 1859, should be dropped from the polyplacophoran fauna of the Paleozoic.

### *eburonicus* (de Ryckholt, 1845), *Pterochiton*

*Chiton eburonicus* de Ryckholt, 1845:53, p. 62, pl. 4, fig. 7–8 (mislabeled as "*Chiton sluseanus*"). Bronn 1848:292. de Koninck 1857:195. Baily 1859:333; 1860:95. Kirkby 1862: 237.
*Helminthochiton eburonicus* (de Ryckholt). Salter 1847:50, 52, fig. 3.
*Anthracochiton eburonicus* (de Ryckholt). Rochebrune 1883: 29.
*Rhombichiton eburonicus* (de Ryckholt). de Koninck 1883: 207.
*Pterochiton eburonicus* (de Ryckholt). Dall 1882:281 [type species of *Pterochiton* Carpenter *in* Dall, 1882, by original designation]. Tryon 1883:339, pl. 85, fig. 67. Smith 1960: I53–I54, fig. 36,9a–b (ex de Ryckholt). Van Belle 1975*b*:136, pl. 2, fig. 2a–b. Sirenko and Starobogatov 1977:36.

Geological Age.—Lower Carboniferous.
Locality.—Belgium: Visé. From "affleurments friables du calcaire anthraxifère supérieur" (de Ryckholt).
Location of Material.—Unknown.

Remarks.—This species is based on intermediate valves with strongly-developed sutural laminae compared with those of *Helminthochiton,* in all probability representing a later evolutionary change. Dall pointed out that de Ryckholt's illustrations of *Chiton eburonicus* are incorrectly labeled "*Chiton sluseanus.*"

De Koninck, Baily, and Rochebrune all believed *Chiton eburonicus* to be closely related to, if not conspecific with, *C. gemmatus* de Koninck, 1844 [=*C. subgemmatus* d'Orbigny, 1850; [non] *C. gemmatus* de Blainville, 1825, a Recent species]. They list it first as a subspecies and later as a synonym of *C. gemmatus* de Koninck, 1844. Rochebrune said he thought an unnamed specimen in the Paris School of Mines from Kildare, Ireland, was probably *C. eburonicus* although he may have been referring to a specimen of *C. thomondiensis* Baily, 1859 from the Carboniferous limestone of County Limerick.

According to Dall (1882) the genus *Pterochiton* included *P. eburonicus* (the type sepcies); *P. legiacus* (de Ryckholt, 1845); *P. gemmatus* (de Koninck, 1844) [at least in part], *P. thomondiensis* (Baily, 1859); *P. sandbergianus* (de Ryckholt, 1845); and *P. sluseanus* (de Ryckholt, 1845).

### *elevatus* (Kues, 1978), *Gryphochiton*

*Pterochiton elevatus* Kues, 1978:308–309, pl. 2, fig. 3, 8.

Geological Age.—Middle Mississippian (Meramecian).
Locality.—USA: Indiana, abandoned Cleveland quarry, SE¼ NW¼, sec. 20, T 7N, R 1W, about 16 km south of Bloomington and 1.8 km north of Harrodsburg, Monroe County.
Location of Material.—Holotype IU 13892 Department of Geology, Indiana University, Bloomington and paratype USNM-244958.

Remarks.—Head and intermediate valves unknown. Tail valve wider than long, highly arched with steep side slopes. Blunt mucro located in posterior fifth of length with steep rugose posterior slope below it. Posterior margin arched upward. Sutural laminae short, narrow and hemielliptical. Central area triangular, widening from mucro to form entire anterior margin, and bounded by shallow furrows. Holotype is 4.7 mm long, 5.5 mm wide, and 3.2 mm high. A paratype is 6.9 mm long, 7.5 mm wide, and 5.1 mm high.

The posterior position of the mucro, arched posterior margin, shape and size of the sutural laminae, and the highly arched nature of the tail valve seem to be consistent with the general characteristics of the genus *Gryphochiton* Gray, 1847*a* rather than *Pterochiton* Carpenter *in* Dall, 1882. The lack of information concerning the inter-

mediate valves and the ventral surface of the tail valves leaves a question as to the correct placement. The amount of variability in the location of the mucro, development of heavy growth ridges, and degree of arching of the tail valve in *G. parvus* (Stevens, 1858) is unknown. *Gryphochiton elevatus,* which is associated with *G. parvus* may possibly be a variant of the latter species.

### *elongata* (Hadding, 1913), *Solenocaris*?

*Anatifopsis*? *elongatus* Hadding, 1913:67, pl. 4, fig. 34. Hadding 1915:31, pl. 4, fig. 27. Gürich 1929:49. Rolfe 1981: 675.

Geological Age.—Upper Ordovician (Llandeilo–Caradoc).

Locality.—Sweden: Collected from exposures along the Laesaa and Riseback rivers, southwest of Aakirkeby.

Location of Material.—Type material in repository of Department of Historical Geology and Paleontology, Lund University, Sweden.

Remarks.—Hadding was uncertain as to the biological affinity of this species believing it might be a phyllocarid crustacean. Gürich (1929) compared it to *Solenocaris.* Since the tail valve is incomplete this assignment must remain provisional.

### *elongatus* Yü, 1984, *Yangtzechiton*

*Yangtzechiton elongatus* Yü, 1984:24–25, pl. 1, fig. 1–7.

Geological Age.—Lower Cambrian (Meishucun).

Locality.—China: Zhongyicun Member, Dengying Formation in eastern Yunnan Province and Huangshandong Member, Töngying Formation in the Yichang District, western Hubei Province.

Location of Material.—Holotype 84131, paratype 84132, Nanjing Institute of Geology and Palaeontology, Academia Sinica.

Remarks.—This species is described by Yü (1984) as follows: "—characterized by the possession of a minute-sized shell of an elongated vermiform and complete coverage. The head valve is small, with a rounded anterior margin, and the posterior margin bears a broadly deep sinus. The intermediate valves are longer than wide with one-half of the valve overlapped by the preceding ones. On the dorsal side at least five valves can be seen clearly, with an elevated elliptical hole in the anterior part of the intermediate valves, which may be the remains of the empty spine after falling off. On the ventral side, all the valves are contiguous with each other and are combined into a single body, but the contiguous fissures still can be seen clearly. In the head valve there is a reniform concavity in the anterior margin and a concave median furrow in the posterior (Pl. I, fig. 3). Of special interest is the occurrence of a varied kind of spicules on the dorsal and ventral sides of the intermediate valves, which may be either separately scattered or gathered in bunches."

The silicified material illustrated by Yü (1984) is composed of incomplete articulated specimens with the holotype, consisting of the head and two intermediate valves being 0.96 mm long and 0.42 mm wide, and a paratype, consisting of the head and four intermediate valves being 0.54 mm long and 0.18 mm wide. The elevated hole on the intermediate valves may well represent an original spinose structure. The degree of overlap of the valves and preservation of spicules are unusual. No evidence of sutural laminae or insertion plates present. A new family, Yangtzechitonidae, erected by Yü, includes *Yangtzechiton* and *Luyanhaochiton,* the latter having spinose projections on the intermediate valves.

### *etheridgei* n. sp., *Acutichiton*

*Chiton cordatus* Kirkby. Etheridge 1882:93–94, pl. 1, fig. 20–22.

Geological Age.—Lower Carboniferous.

Locality.—England: From the Main or Hurlet Limestone, Law Quarry, near Dalry, Ayrshire (Etheridge).

Location of Material.—Collections of J. Bennie, J. Smith, etc. (fide Etheridge). Present location of material unknown.

Remarks.—The specimens described by Etheridge as *Chiton cordatus* Kirkby, 1859 are radically different from those described by Kirkby particularly in the presence of a well-developed hypotyche on the tail valve. Etheridge says "Viewed from the interior the plate is seen to be of considerable thickness towards the posterior, forming a smooth triangular surface of attachment destitute of markings of any kind." This feature plus the terminal mucro, triangular shape, and narrow, but well-developed sutural laminae differentiates this species from *Chiton cordatus* Kirkby, 1859. These characteristics also allow the species to be placed in *Acutichiton* Hoare, Sturgeon, and Hoare, 1972.

The specimen illustrated by Etheridge on plate 1, figures 20 and 21 is hereby selected as the lectoholotype for the species.

Using Etheridge's illustrations and stated magnifications the lectoholotype is about 3.2 mm long, 2.8 mm wide, and 1.2 mm high. The length of the hypotyche along the median line of the second specimen is 0.88 mm.

### *exsectionis* Trenkner, 1868, "*Chiton*"

*Chiton exsectionis* Trenkner, 1868:137, pl. 2, fig. 31. Clarke 1885:340, pl. 4, fig. 18–19.

GEOLOGICAL AGE.—Upper Devonian.
LOCALITY.—Germany: Ohemannsbrink, Hartz Mts.
LOCATION OF MATERIAL.—Unknown.

REMARKS.—Based on a single tail valve, a steinkern, close to *Chiton inflatus* Trenkner, 1868. Measurements are: length, 16 mm; width, 13 mm.

### *expansa,* Ulrich and Bridge *in* Butts, 1941, *Hemithecella*

*Hemithecella expansa* Ulrich and Bridge *in* Butts, 1941:19–20, pl. 68, fig. 6 [type species of *Helmithecella* Ulrich and Bridge, 1941]. Runnegar, Pojeta, Taylor, and Collins 1979:1389, pl. 1, fig. 31, 32.

GEOLOGICAL AGE.—Lower Ordovician (Gascondian).
LOCALITY.—USA: Missouri. Gasconde Dolomite, USNM loc. 104 (old series), Decaturville, Camden County.
LOCATION OF MATERIAL.—Holotype, USNM-96211; paratype (?) USNM-97289.

REMARKS.—The holotype is a silicified external mold of a body valve. The mold of the filling of the posterior hole and the growing edge of the valve is preserved. Runnegar et al. (1979) said that the preservation of the questionable paratype figured by Ulrich and Bridge *in* Butts (1941) is not well enough preserved to definitely assign it to this taxon. They also said that *Hemithecella expansa* is intermediate in form between *Matthevia* and *Chelodes.*

### *fasciatus* Sandberger, 1842

*Chiton fasciatus* Sandberger, 1842:399. Nomen nudum. de Ryckholt 1845:62. Salter 1847:49, 51 (footnote). Bronn 1848: 292. de Koninck 1857:192 (and footnote). Baily 1859:333; 1860:92 (and footnote). Rochebrune 1883:22–23.
See: *Chiton sagittalis* Sandberger and Sandberger, 1856 which replaces this species name.

REMARKS.—*Chiton fasciatus* was introduced but not described by Guido Sandberger in 1842. In any event, the name *fasciatus* was nomenclatorially unavailable in 1842, being preoccupied by *Chiton fasciatus* Wood, 1815 [=*C. squamosus* Linné, 1764], by *Chiton fasciatus* Quoy and Gaimard, 1835 [=*Cryptoplax larvaeformis* (Burrow, 1815)], and possibly also by *Chitonellus fasciatus,* Reeve, 1847 [=*Cryptoplax oculatus* Quoy and Gaimard, 1835].

### *fornicis,* Hoare and Smith, 1984, *Lekiskochiton*

*Lekiskochiton fornicis* Hoare and Smith, 1984:95–96, fig. 7O–X [type species of *Lekiskochiton* Hoare and Smith, 1984, by original designation].

GEOLOGICAL AGE.—Middle Permian (Leonardian).
LOCALITIES.—USA: Texas, Road Canyon Formation, USNM loc. 726d, 726z, Glass Mts., West Texas.
LOCATION OF MATERIAL.—Holotype, USNM-330863; paratypes, USNM-330864, 330873.

REMARKS.—Known only from three specimens, one intermediate and two tail valves, *Lekiskochiton fornicis* appears to be closely related to some of the specimens described as *Chiton cordatus* by Kirkby (1859), especially those indicated as intermediate valves (pl. 16, fig. 25, 26), from the Permian of the British Isles. His illustrations of tail valves are discounted as polyplacophoran remains.

Based upon an illustration by Kirkby and Young (1867) the head valve of this genus may be narrowly triangular with a prominent apex, although none have been recovered from the Permian of West Texas. The intermediate valve of *Lekiskochiton fornicis* is cordate in shape, low-arched (jugal angle averages 135°), with a raised jugal area, a small apical area, and narrow sutural laminae although the anterior extensions of the laminae are missing. The tail valve is narrowly triangular in shape with an overhanging, terminal mucro above an arched posterior margin, and narrow sutural laminae. The valves are smooth except for coarse, irregular ridges on the lower side-slopes which intersect the lateral margins.

Average dimensions are (mm):

| | Intermediate | Tail |
|---|---|---|
| Length | 8.5 | 6.7 |
| Width | 6.8 | 4.1 |
| Height | 2.4 | 3.1 |

The new genus *Lekiskochiton* Hoare and Smith, 1984 was erected to include those species with cordate or subtriangular intermediate and tail valves that are low-arched and have an elevated terminal mucro above an arched posterior margin.

*geikiei* (Etheridge, 1882), *Chauliochiton*?

*Chiton geikiei* Etheridge, 1882:94–95, pl. 2, fig. 1–3.

GEOLOGICAL AGE.—Lower Carboniferous (Main or Hurlet Limestone).

LOCALITY.—Scotland: Ayrshire, from the Law Quarry near Dalry (Etheridge).

LOCATION OF MATERIAL.—Collection of J. Smith (fide Etheridge). Present location of material unknown.

REMARKS.—This species is well described by Etheridge, based on both head and tail valves, the latter with small but rather broad sutural laminae. The head valve is "semi-conical, snout-like, and convex, anteriorly pointed, posteriorly truncately rounded." Ventrally, it has an extensive apical area. The tail valve is described as rectangular with a broadly-rounded, posterior margin, but it appears that the illustration is of an articulated semicircular tail valve and subquadrate intermediate valve. Major sculpture on the head valve consists of blunt, microscopic tubercles arranged in transverse lines, on the tail valve, fine granulations. The lateral margins of the head valve and the posterior margin of the intermediate valve are decorated with a row of projections, or pectinations (Etheridge called them acute spinelets), a sculptural feature not hitherto reported to occur on any Paleozoic species, but reminiscent of a somewhat similar sculptural characteristic of Recent species in the genus *Lepidozona* in the Ischnochitonidae. Hoare and Smith (1984:96) have described a new genus, *Chauliochiton,* from the Permian of West Texas which has spines along the posterior margins of the intermediate valves. Head and tail valves are unknown. Assignment of *Chiton geikiei* to this genus is provisional.

Valve measurements were not supplied by Etheridge (1882). These would be about as follows, based on the scale of his illustrations (mm):

| Valve | Length | Width |
|---|---|---|
| Head | 1.9 | 2.6 |
| Intermediate | 1.5 | 2.3 |
| Tail | 1.0+ | 2.0 |

The present systematic position of *Chiton geikiei* is problematical and its assignment to *Chauliochiton* at this time may be premature, the shape of the intermediate valves and ornamentation being radically different.

*gemmatus* de Koninck, 1842

*Chiton gemmatus* de Koninck, 1844:323, pl. 23, fig. 2a–e. See: *subgemmatus* d'Orbigny (1850).

REMARKS.—De Koninck's name is preoccupied by *Chiton gemmatus* de Blainville (1825), a Recent species. Renamed by d'Orbigny in 1850.

*gibberosus* (Sardeson, 1896), *Chelodes*

*Ascoceras gibberosum* Sardeson, 1896:102, pl. 6, fig. 8–10.
*Chelodes gibberosus* (Sardeson). Smith *in* Smith and Toomey 1964:14.

GEOLOGICAL AGE.—Lower Ordovician (Oneonta Dolomite).

LOCALITY.—USA: Minnesota, Dresbach, in the Oneonta Dolomite.

LOCATION OF MATERIAL.—Type and related specimens in the Department of Geology, University of Minnesota. Photographs in CAS.

REMARKS.—Examination of the type and other valves of this species established the fact that it should be assigned to the Paleoloricata, genus *Chelodes.* The holotype is a well-preserved intermediate valve. There are two other quite similar valves. These measure (mm):

| Valve | Length | Width | Height | Max. thickness at jugum |
|---|---|---|---|---|
| Holotype | 15.0 | 8.5 | 7.9 | * |
| Valve A | 13.0 | 8.1 | 6.8 | 4.0 |
| Valve B | 13.0 | 9.6 | * | 4.3 |

* These dimensions could not be taken accurately.

All three valves are much alike, with the anterior end notched by an almost semicircular sinus, and the posterior end rounded. They differ in shape from *Chelodes bergmani* Davidson and King, 1874, which has a nearly squared-off anterior and a much more pointed posterior margin. In Valve A the internal ridge is broadly V-shaped, the distance from the valve margins to the posterior margin being 6.6 mm, while from the center of the ridge along a median line this distance is 4.8 mm.

There is another valve in the series, which may be a head valve. This has a sharply pointed posterior end, with the tegmentum rolled over onto the ventral side, forming a V-shaped pocket under the valve apex. The anterior margin is not complete but gives the impression of having a shallower anterior sinus than occurs on the other three valves. This possible head valve is 12.4 mm long and has a maximum width of 9.4 mm.

cf. *gibberosus* Sardeson, 1896, *Calceochiton*

*Calceochiton* cf. *C. gibberosus* (Sardeson, 1896). Flower 1968: 10, pl. 1, fig. 10–24.

GEOLOGICAL AGE.—Lower Ordovician (Oneonta Dolomite).
LOCALITY.—USA: Near Sauk City, Wisconsin.
LOCATION OF MATERIAL.—Figured specimens 1269–1274, New Mexico Bureau of Mines and Mineral Resources.

REMARKS.—"These chiton plates from the Oneonta show some variation in proportions, illustrated in our Pl. 1, fig. 10–24, but show rounded dorsal surfaces in cross section, nearly straight sides, gently converging apically, and concave anterior margins. Rate of expansion varies from the broad form shown in fig. 10, to the slender one in fig. 18; in profile some plates are convex dorsally, others straight, while fig. 17 shows a shell that is slightly concave.

"This is allied to the preceding form [*Calceochiton hachitae* Flower, 1968], but is larger, shows better growth lines, the shell shows less apical thickening, and we have no specimens in which the ventral cavity is surely enclosed below. These forms are figured here as examples of a relative of *C. hachitae* in the Oneonta Dolomite of Gasconade age. Further work may show more than one species in this association and may be the explanation of the wide variation in profile and rate of expansion" (Flower 1968:10).

The conservative taxonomic approach would be to identify this material as *Calceochiton hachitae* until additional data are obtained that prove otherwise. The valves from Sauk City should not be equated with *Chelodes gibberosus* Sardeson, 1896 which is subquadrate in shape, not lanceolate, although both series of valves are found in the Oneonta Dolomite, the latter being collected near Dresbach, Minnesota.

### *gibbosus* Trenkner, 1868, "*Chiton*"

*Chiton gibbosus* Trenkner, 1868:138, pl. 2, fig. 33. Clarke 1885: 339, pl. 4, fig. 12, 13.

GEOLOGICAL AGE.—Upper Devonian.
LOCALITY.—Germany: Winterberg, Hartz Mts.
LOCATION OF MATERIAL.—Unknown.

REMARKS.—The type is an intermediate valve measuring: length, 12 mm and width, 20 mm. It is the only specimen that has been described or illustrated. The posterior and anterior margins are subparallel with the lateral margins converging anteriorly giving a trapezoidal shape. A deep furrow crosses the valve at about midline forming two pronounced humps along the jugal area, both of which project over the valve margins. Sutural laminae are described as strongly developed and sloping. The valve surface is ornamented by numerous, fine, closely spaced, irregular, concentrically arranged ridges composed of small tubercles.

### *girtyi* (Hoare and Smith, 1984), *Gryphochiton*

*Helminthochiton girtyi* Hoare and Smith, 1984:92–93, fig. 6 (reconstruction), 7A–G.

GEOLOGICAL AGE.—Middle Permian (Leonardian).
LOCALITY.—USA: Texas, Road Canyon Formation, USNM loc. 726d, Glass Mts., West Texas.
LOCATION OF MATERIAL.—Holotype, USNM-330865; paratypes, USNM-330866–330872.

REMARKS.—A reconstructed specimen measures approximately 65 mm in length and 15 mm in width, giving a length to width ratio of 4.3:1. The head valve is unknown. The intermediate valves are subquadrangular, low-arched (jugal angle averages 115°), with straight side-slopes only slightly set off from jugal area, and probably small and narrow sutural laminae although they are not well preserved. The tail valves are broadly subtriangular to subquadrate in plan view, low-arched, with distinct jugal area, and mucro located close to posterior margin. Sutural laminae not preserved. Ornamentation of heavy growth lamellae paralleling the anterior and lateral margins on the intermediate valves and similar lamellae on the lateral and posterior margins of the tail valves. The fine granular ornamentation, normally present on specimens of *Gryphochiton* appears not to have been preserved in the siliceous replacement of these specimens.

Average dimensions are (mm):

| | Intermediate | Tail |
|---|---|---|
| Length | 10.3 | 10.0 |
| Width | 11.3 | 13.2 |
| Height | 4.1 | 5.1 |

### *gotlandicus* Lindström, 1884, *Chelodes*

*Chelodes gotlandicus* Lindström, 1884:51–52, pl. 2, fig. 9–27. Etheridge 1897:69. Bergenhayn 1955:9–12, pl. 1, fig. 1–2; pl. 2, fig. 1. Sirenko and Starobogatov 1977:31.

GEOLOGICAL AGE.—Silurian (Gotlandian) [Lindström]. Middle Silurian (Etheridge).
LOCALITIES.—Sweden: Grötlingbo (several specimens); öolite quarry near Gannviken; sandstone at Burgsvik; öolite near Rone; limestone above Kålens qvarn, near Visby (Lindström). Wenlock, Gotland (Etheridge).
LOCATION OF MATERIAL.—Holotype, RM-5098 and additional specimens (fide Bergenhayn, 1955).

REMARKS.—The species is based on both intermediate and tail valves. One intermediate valve is massive and has a length of 17.3 mm. The anterior margin has a deep sinus compared with *Chelodes bergmani* Lindström, 1884, which has an almost straight anterior margin, without the slightest evidence of any emargination. The apex of *C. gotlandicus* is more rounded than in *C. bergmani,* which tends to be pointed. Bergenhayn calculated a total shell length, exclusive of the girdle, of about 102 mm for the species.

Lindström said that both species were found together, *C. bergmani* being of much rarer occurrence.

### *grayanus* de Koninck, 1857, "*Chiton*"

*Chiton grayanus* de Koninck, 1857:196–198, pl. 1, fig. 1a–d. Baily 1859:333. de Koninck 1860:96–97, pl. 2, fig. 1a–d. Woodward 1865:487. Dall 1882:283. Rochebrune 1883:19.

GEOLOGICAL AGE.—Lower Silurian (Wenlock Limestone) (de Koninck). Upper Silurian (Baily (1860), Dall, Rochebrune).
LOCALITY.—England: Dudley, Worcester (north of Birmingham).
LOCATION OF MATERIAL.—BM (N.H.) (fide H. W. Ball).

REMARKS.—The original description of *Chiton grayanus* is based on intermediate valves only, no end valves having been found. Insertion plates, if any, are not preserved. De Koninck gave the length of a valve as about 12 mm and the width about 10 mm. He estimated a complete animal would have been 80–90 mm long and 16–18 mm wide.

De Koninck's drawings are stylized. His figure 1a is of a piece of matrix with fragments of four valves, two of which are adjacent, apparently in normal position. Figure 1b shows an end view of a complete valve. Figure 1c is an enlarged view of sculptural detail. Figure 1d is a hypothetical reconstruction of the valves of an entire animal, the configuration of the end valves being pure guesswork. From the description and figures the intermediate valves are almost square, the anterior corners rounded, and the anterior margins slightly emarginate; the side margins are straight.

Dall (1882) said *Chiton grayanus* was not a polyplacophoran, listing it with others he thought were fish scales, barnacle plates (*Turrilepas*), ostracode crustaceans, or other undetermined organisms. Because of the uncertainty of the existence of sutural laminae or insertion plates (or both), this species cannot be assigned to any presently recognized families or genera with confidence. If, on subsequent study, the valves lack an articulamentum layer this species could be assigned most probably to the family Gotlandochitonidae; if such a layer is present this species could be placed in the Lepidopleuridae. De Koninck compared his species with *Gryphochiton priscus* (Münster, 1839) and *G. mempiscus* (de Ryckholt, 1845), both Carboniferous species in the Lepidopleuridae.

### *grayi* de Ryckholt, 1862. Genus *incertae sedis*

*Sulcochiton grayi* de Ryckholt, 1862:259–260, pl. 12, fig. 14. Dall 1879:315. Etheridge 1882:86. Dall 1882:283. Rochebrune 1883:35–36. Tryon 1883:339. Fischer 1885:879. Iredale and Hull 1926:326; 1927:141.

GEOLOGICAL AGE.—Lower Carboniferous.
LOCALITY.—Belgium: Visé.
LOCATION OF MATERIAL.—Unknown.

REMARKS.—This species was considered by Dall, Etheridge, and other reviewers as not being a polyplacophoran, a view that seems to be correct. It is based on a small head(?) valve, divided into two halves by a half-obliterated groove passing from the summit to the margin. From the illustrations it appears more likely to be a species of brachiopod.

### *grayiae* (Woodward, 1885), *Septemchiton*

*Helminthochiton grayiae,* Woodward, 1885:352, pl. 9, fig. 7–10 [non Reed, 1907:113–114, pl. 4, fig. 8 (mislabeled as fig. 12)]. Robson 1913:304.
*Septemchiton vermiformis* Bergenhayn, 1955:24–26, pl. 1, fig. 15 (type), pl. 2, fig. 13 (reconstruction), 13a–b. Smith 1960: 150, fig. 35,1a–f (ex Bergenhayn). Van Belle 1975*a*:126, pl. 1, fig. 11. Sirenko and Starobogatov 1977:32, fig. 1c, d, 2c.
*Septemchiton grayiae* (Woodward). Rolfe 1981:677, text-fig. 1, 2 [type species of *Septemchiton* Bergenhayn, 1955].

GEOLOGICAL AGE.—Upper Ordovician (Ashgillian).
LOCALITY.—Scotland: Upper Bala beds at Thraive, near Girvan, Ayrshire (Woodward). Starfish bed, Drummock Group, Ashgill, Lady Burn, Girvan (Robson, Rolfe).
LOCATION OF MATERIAL.—Woodward's figured specimen (holotype?) and Reed's figured specimen (hypotype?) along with other related material in BM (N.H.) (fide H. W. Ball). Additional material figured by Rolfe (1981) in the Begg and Lamont collections at the Hunterian Museum, Glasgow University (HM S. 3828/1 and HM S. 14902a).

REMARKS.—Bergenhayn's (1955) interpretation of this form as a 7-valved species has been shown to be incorrect by Rolfe (1981). The type and additional material shows a small head valve present. The erection of a separate suborder, Septemchitonina by Bergenhayn is unnecessary. *Septemchiton vermiformis* Bergenhayn (1955) is

a subjective junior synonym of *S. grayiae* (Woodward, 1885). Both Reed (1907) and Robson (1913) doubted this species is a polyplacophoran, believing it may be a crustacean. Rolfe's diagnosis appears correct. Rolfe *in* Morris (1967) had synonomized *Septemchiton* with *Solenocaris* Young and Young *in* Young, 1868.

### *griffithi* Salter *in* McCoy, 1846, *Helminthochiton*

*Helminthochiton griffithi* Salter *in* McCoy, 1846, addenda:71, pl. 5, fig. 5a–e [type species of *Helminthochiton* Salter, 1846, by original designation]. Salter 1847:51, fig. 6. Etheridge 1882:85. Dall 1882:280. Rochebrune 1883:18–19, pl. 3, fig. 7. Tryon 1883:339, pl. 85, fig. 58. Smith 1960:152, fig. 36,2a–b. Sirenko and Starobogatov 1977:33.

*Chiton* (*Helminthochiton*) *griffithi* (Salter). de Koninck 1857: 193, 196. Baily 1859:333; 1860:96.

Geological Age.—Silurian (Salter). Lower Silurian (Rochebrune).

Locality.—Ireland: Cong, County Galway.

Location of Material.—Unknown.

Remarks.—This is the type species of *Helminthochiton* Salter *in* McCoy (1846), by original designation. Salter (1847) says: "Mr. Griffiths found it a year or two back in the silty mudstone overlying the fossiliferous conglomerate of Cong, co. Galway."

Sirenko and Starobogatov (1977) disagree with the assignment of *Helminthochiton griffithi* to the Loricata and place it in the Paleoloricata. Because of the uncertainty of the characteristics of this taxon the upper Paleozoic species, which have commonly been assigned to *Helminthochiton,* are here assigned to *Gryphochiton* Gray, 1847*a*.

### *hachitae* Flower, 1968, *Calceochiton*

*Calceochiton hachitae* Flower, 1968:10, pl. 1, fig. 1–9 [type species of *Calceochiton* Flower, 1968, by original designation]. Van Belle 1975*a*:124, pl. 1, fig. 4a–c. Sirenko and Starobogatov 1977:31.

Geological Age.—Lower Ordovician (Big Hatchet Formation).

Locality.—Mescal Canyon section, Big Hatchet Mts., New Mexico, in the *Kainella* zone in a bed 52.4 m above the base of the Paleozoic.

Location of Material.—Syntypes, 1264–1266 and additional unfigured specimens 1267, 1268 in New Mexico Bureau of Mines and Mineral Resources.

Remarks.—"Plates of this form are without observed growth lines. The tip, generally wanting, has the shell growing over the under side enclosing a small cavity below, and is, from indications of the various specimens, quite strongly pointed. The various shells show considerable variation in convexity and the nature of the cross section. Pl. 1, fig. 1–3 show a strongly convex specimen, the interior of which shows a median longitudinal concave angle. The most gently rounded form is shown in Pl. 1, fig. 7–9. The anterior margins of the plates, rarely perfect, are slightly concave.

"These plates show some variation in proportion, but our greatest length is 11 mm, the greatest width 6 mm. They are smooth externally, thicken apically and close around the under surface, and are concave anteriorly" (Flower 1968: 10).

Flower compared this species with valves from the Oneonta Dolomite of Sauk City, Wisconsin, which he identified incorrectly, as *Calceochiton* cf. *C. gibberosus* Sardeson, 1896. Both the Big Hatchet and the Sauk City specimens are lanceolate in general shape rather than subquadrilateral with straight side-slopes, which can be assumed to be the major difference between the genera *Calceochiton* and *Chelodes. Calceochiton* Flower, 1968, undoubtedly should be allocated under the family Mattheviidae, in the order Paleoloricata.

### *hami* Smith *in* Smith and Toomey, 1964, *Gotlandochiton*

*Gotlandochiton hami* Smith *in* Smith and Toomey, 1964:28–30, pl. 7, fig. 1–15.

Geological Age.—Lower Ordovician (Kindblade Formation).

Localities.—USA: Oklahoma. Type lot from the lower part of the Kindblade Formation, Mill Creek section, Arbuckle Mts. Also from Highway 77 section interval within the Kindblade Formation, in a zone of abundant *Calathium.*

Location of Material.—Holotype, OU-5223; paratypes OU-5224–5227, 5232. Paratypes, USNM-144541–144545. Paratypes, CAS-12593–12598. Six additional valves from the Highway 77 section are at OU.

Remarks.—Valves representing this species were acid-etched from limestone blocks. No end valves were recovered. The preservation is relatively poor. The type lot consists of 17 valves, with 6 additional valves from the second locality indicated above. Distinguishing features include a fairly sharp jugal ridge, a pointed but not projecting apex, a triangular jugal area that is not distinct, straight side-slopes with a slight narrowing of the valves anteriorly, and a well-developed apical area ranging in width from 0.5

to 1.0 mm. Any evidence of dorsal sculpture has been obliterated during fossilization. The holotype valve is 8.6 mm long, 12.4 mm wide, and 5.3 mm high; thickness at the jugum is 1.5 mm; the angle of divergence is 104°.

*hancockianus* Kirkby, 1859.
Genus *incertae sedis*

*Chitonellus hancockianus* Kirkby, 1859:611, 621–623, pl. 16, fig. 1–13. Baily 1860:95. Kirkby 1860:257–260, pl. 13, fig. 1–13. Young 1878:324. Dall 1882:283. Rochebrune 1883: 38–39. Yochelson 1971:131.
*Chiton hancockianus* (Kirkby). Baily 1859:333.

GEOLOGICAL AGE.—Permian.
LOCALITY.—England: Durham, Tunstall, and Humbleton Hills.
LOCATION OF MATERIAL.—Unknown.

REMARKS.—The species is based on a single, so-called tail valve, five intermediate valves, and a few fragments interpreted as girdle spines. One of Kirkby's illustrations shows a supposed tail valve, square in shape, with small, obliquely placed sutural laminae and a denticulated posterior margin. Dorsal sculpture consists of broad ribs radiating from a central apex. The size would be around 4.5 mm in both length and width. Other illustrations show smaller intermediate valves that are asymmetric in shape with one sutural lamina much longer than the other. The so-called spines, which are somewhat less than 2.5 mm long, have two terminal projections, like tiny sutural laminae.

Both Dall and Rochebrune considered *Chitonellus hancockianus* to be a doubtful polyplacophoran. If Kirkby's illustrations are correctly drawn, these fossils are certainly not polyplacophoran, even allowing for considerable distortion during fossilization. As for the spines, no such girdle decoration is known for any Recent species of polyplacophoran and it seems doubtful that any relationship exists between these and the so-called valves. Pending further study this species should be dropped from the list of valid Paleozoic polyplacophorans.

*howseanus* (Kirkby, 1857), *Cymatochiton*?

*Chiton howseanus* Kirkby, 1857:216, pl. 7, fig. 9–13. Howse 1858:435, 463–464. Kirkby 1858:290, pl. 12, fig. 9–13; 1859: 615–616, pl. 16, fig. 42–53; 1860:248–250, pl. 13, fig. 42–53. de Koninck 1857:198. Baily 1859:333; 1860:94. Yochelson 1971:131.
?*Cymatochiton howseanus* (Kirkby). Dall 1882:282.
*Protalochiton howseanus* (Kirkby). Rochebrune 1883:37.

GEOLOGICAL AGE.—Permian.
LOCALITY.—England: Durham, Tunstall, and Humbleton Hills (Kirkby).
LOCATION OF MATERIAL.—Specimens under this name in BM (N.H.) (fide H. W. Ball). Location of type material unknown.

REMARKS.—According to Kirkby (1857), this species is rare. In addition to the original material, he mentioned collecting four additional valves, three intermediate and one tail valve. Although some of his illustrations do not show sutural laminae, his figures 51–53 do show them. His original illustrations are worthless for diagnostic purposes, but his later ones (1859) are better. In the later paper he speaks of "processes of insertion angulate, obliquely truncate, the upper edge projecting." He thought *Chiton howseanus* and *C. loftusianus* were closely related and said that "*C. priscus* of the Carboniferous rocks of Belgium seem to belong to the same elongate type . . . ." *Chiton howseanus* has a granular sculpture on the dorsal valve surfaces.

In all probability, *Chiton howseanus* may be accepted as a valid polyplacophoran species, following Dall (1882). Rochebrune's (1883) assignment to his genus *Protalochiton* is unnecessary.

*humilis* Kirkby *in* Young, 1865, "*Chiton*"

*Chiton humilis* Kirkby *in* Young, 1865:14, pl. 1, fig. 1. Kirkby and Young 1867:341, pl. 16, fig. 6a–c. Etheridge 1882:90. Rochebrune 1883:33.

GEOLOGICAL AGE.—Carboniferous.
LOCALITY.—Western Scotland: Calcerous shale, Robroyston beds northeast of Glasgow.
LOCATION OF MATERIAL.—Unknown.

REMARKS.—Kirkby and Young (1867) said the species was based on an imperfect tail valve that may be a polyplacophoran. Etheridge (1882) stated his *Chiton armstrongianus* had an outline approaching *C. humilis* but was more pointed behind and less acute in front, the impressed concentric grooves were less in number and exhibited certain differences in shape. Another valve from Williamwood, near Cathcart, Renfrewshire, he believed to be an intermediate form. However, Rochebrune (1883) said Kirkby's specimen should be identified as *Metapoma pileus* and therefore was not a polyplacophoran.

The validity of *Chiton humilis* would seem questionable, although from the description and the illustrations it seems to have strong polyplacophoran aspects.

*inflatus* Trenkner, 1868, "*Chiton*"

*Chiton inflatus* Trenkner, 1868:136, pl. 2, fig. 26. Clarke 1885: 339, pl. 4, fig. 16–17.

GEOLOGICAL AGE.—Upper Devonian.
LOCALITY.—Germany: Winterberg, Hartz Mts., in the Iberger Kalk.
LOCATION OF MATERIAL.—Unknown.

REMARKS.—The species is based on a single specimen, possibly representing a head valve 33 mm long and 25 mm wide. Clarke (1885) said it somewhat resembled *Chiton laevigatus* Roemer, 1855 from the same general locality.

The lack of suitable material leaves the validity of *Chiton inflatus* in doubt.

*insignis* Jahn, 1893. Genus *incertae sedis*

*Duslia insignis* Jahn, 1893:591–603, pl. 1, fig. 1–4. Pilsbry 1900:511. Pompeckj 1912:357. von Knorre 1925:497–499, fig. 1. Quenstedt 1931:555; 1932:86.

GEOLOGICAL AGE.—Lower Silurian.
LOCALITY.—Bohemia.
LOCATION OF MATERIAL.—Unknown.

REMARKS.—Jahn (1893) described this as a species with 12 or more valves. Pilsbry (1900) believed this to be a crustacean as did Pompeckj (1912). Knorre (1925) reinterpreted the specimen as an 8-valved polyplacophoran, but his interpretation of the shape of the sutural laminae appears to be inconsistent with lower Paleozoic Polyplacophora. This taxon is here rejected as a polyplacophoran.

*intermedius* Bergenhayn, 1960, *Chelodes*

*Chelodes intermedius* Bergenhayn, 1960:174–175, fig. 11–14. Sirenko and Starobogatov 1977:31.

GEOLOGICAL AGE.—Lower Ordovician (Chapultepec Formation).
LOCALITY.—USA: Virginia, from the Chapultepec Formation 92.9 m below the *Ceratopea* zone, at the top of the path from office to tunnel, Natural Tunnel, Scott County.
LOCATION OF MATERIAL.—Holotype, USNM-137375.

REMARKS.—*Chelodes intermedius* is based on three intermediate valves and four tail valves. The intermediate valves are wedge-shape or heart-shaped, with an apical area as long or slightly longer than half their length. The holotype has a length of 17 mm. Bergenhayn estimated the total length of the animal, excluding the girdle, to be 69 mm, with a ratio of length to width of about 4. Assignment to the genus *Chelodes* is correct for this species.

*interplicatus* Bergenhayn, 1955, *Gotlandochiton*

*Gotlandochiton interplicatus* Bergenhayn, 1955:15–16, pl. 1, fig. 6; pl. 2, fig. 4 [type species of *Gotlandochiton* Bergenhayn, 1955, by original designation]. Smith 1960:150, fig. 34,4; 34,7 (ex Bergenhayn). Van Belle 1975*a*:125. Sirenko and Starobogatov 1977:31.

GEOLOGICAL AGE.—Silurian (Gotlandian).
LOCALITY.—Sweden: Klints Othem, Gotland.
LOCATION AND MATERIAL.—Holotype, RM Mo-6012.

REMARKS.—The species is based on an intermediate valve 10.5 mm long, which includes a fragment of another posterior to it.

*iowensis* (Sanders, 1965), *Septemchiton*

*Bursata iowensis* Sanders, 1962:102.
*Septemchiton iowensis* (Sanders). Sanders 1965:94–98, fig. 1–12.

GEOLOGICAL AGE.—Upper Ordovician (late Edenian).
LOCALITY.—"Depauperate Zone, basal Maquoketa Shale . . . one mile northeast of Graf, Iowa, on the northwest side of Highway 52, just beyond the second crossing of the Little Maquoketa River: SE¼ NW¼ SE¼ SE¼ Sec. 20, T 89 N, R 1 E" [Sanders, 1965].
LOCATION OF MATERIAL.—Cotype material, OU-4470.

REMARKS.—These small polyplacophoran plates, ranging from 1.0–3.5 mm long and 0.5–1.0 mm wide, were acid-etched from a glauconitic phosphatic shale and are abundant at the type locality. They were described originally by Ladd (1925) as *Ceratiocaris* (*Limnocaris*) *praecedens*, a phyllocarid crustacean. Rhoads (1962) restudied these fossils, concluding they were not crustacean but problematical animals, which he termed "tegmates," and described them under the new generic and specific names of *Bursata iowensis, B. maquoketensis, B. bellevuensis, Subcylindrica elginensis, S. laddi,* and *Triangulata simplex.* Rhoads's material came from Scales Mound, Illinois and Bellevue and Graf, Iowa, also in the basal Maquoketa Shale; his types and other specimens are deposited in the Department of Geology, State University of Iowa, Iowa City, Iowa. His illustrations of the various forms described are excellent enlargements.

Further study led Sanders to the conclusion that these peculiar small fossils were, in fact, polyplacophoran plates referable to the genus *Septemchiton* established by Bergenhayn (1955) for a 7-valved polyplacophoran from the Middle Ordovician of south Scotland (*S. vermiformis*). Through the courtesy of Dr. Sanders and of Dr.

Ellis Yochelson of the U.S. Geological Survey, a large number of these fossils have been examined and we concur with the former's conclusion that they are polyplacophorans. There is no evidence, nor has it been suggested, that *S. iowensis* is normally 7-valved; it could just as well be 8-valved. Sanders's allocation of specimens to head, intermediate, and tail valves seems correct. His illustrations also are excellent and should be studied in conjunction with those furnished by Rhoads.

Several features relating to *Septemchiton iowensis* are of special interest. The first is its small size, even assuming its habitat was a specialized niche, or depauperate zone where associated invertebrates all were dwarfed forms. Very few Recent polyplacophorans are normally so small and only a few even approach the presumed total length of 22 mm and minimum width of 0.8 mm, with a length to width ratio of 32:1. *Septemchiton vermiformis* has a 17:1 ratio. The longest and narrowest known Recent polyplacophoran is *Stenochiton longicymba* (Quoy and Gaimard, 1835), which has a length to width ratio of less than 7:1; other *Stenochiton* species (all from Australia) have ratios ranging from 3:1 to 5:1. While the habitat of Recent *Stenochiton* is on or in the stipes of eel-grass this is believed to be a more recent adaptation and one might postulate that a polyplacophoran such as *S. iowensis* might have lived in a habitat of fine mud or muddy sand rather than on some hard substrate.

Another feature is the apparent lack of overlap of one valve on another. Many of the valves have what appears to be a somewhat everted apex at the posterior margin, with a shallow sinus in the anterior margin. This might mean that in the living animal the valves merely abutted, or even that they were slightly separated as in some species of the Recent genus *Cryptoplax* in the adult stage. Such an arrangement would give the animal extreme flexibility in all directions, assuming it had a more or less normal form of girdle. An animal with such a degree of flexibility suggests a possible closer ralationship between the Polyplacophora and the Aplacophora than has hitherto been apparent from the fossil record (there being none for the latter subclass). Although all solenogastres (Aplacophora) lack any calcareous plates when adult, it has been shown that some species do form such plates in the larval stage of development and that these are adsorbed long before the animal becomes adult. The evolutionary implications of such a relationship if, in fact, it can be shown to exist, are of more than passing interest.

Many of the plates of *Septemchiton iowensis* show a well-preserved network of rather coarse, cylindrical punctae filled with a darker phosphatic material (Sanders 1965, fig. 3, 9; Rhoads 1962, pl. 178, fig. 9 especially). These are easily seen under magnification in many of the plates at hand. No other Paleozoic polyplacophoran valves have been seen to exhibit this feature. Sanders pointed out (1965:95) that these punctae "lack the interconnecting canal system of the 'eyes' of modern chitons." Whether or not this is a character that is general for all primitive polyplacophorans or is limited to this particular species one cannot now say. It certainly is unique as far as present knowledge of the group extends.

### *juxtaterminus* Hoare and Mapes, 1985*a*, *Elachychiton*

*Elachychiton juxtaterminus* Hoare and Mapes, 1985*a*:880–881, fig. 3.

Geological Age.—Upper Mississippian (Chesterian).

Locality.—USA: Arkansas, Imo Formation exposed in roadcut just south of the Van Buren Co. border on U.S. Hwy. 65, about 6.4 km SE of Leslie, NE¼, sec. 11, T 13N, R 15W, Searcy Co. Leslie 7½-minute Quadrangle.

Location of Material.—Holotype, OSU-36999; paratypes, OSU-37000–37008; BGSU-4449.

Remarks.—Reconstructed specimens are small, about 20 mm long with fine granulose ornamentation. The intermediate valves are highly arched with broadly rounded sutural laminae. The tail valve is triangularly elongate with a well-developed hypotyche and a mucro located just anterior to the posterior margin. The head valve is unknown.

Average dimensions are (mm):

| | Intermediate | Tail |
|---|---|---|
| Length | 2.3 | 5.6 |
| Width | 3.3 | – |
| Height | 1.6 | 2.6 |

### *kaibabensis* (Brady, 1955), *Cymatochiton*?

*Rhynchoteuthis kaibabensis* Brady, 1955:102–104, pl. 21.
*Cymatochiton*? *kaibabensis* (Brady). Yochelson 1971:130–133, text-fig. 1A–J.

Geological Age.—Middle Permian.

Locality.—USA: Arizona (Kaibab Limestone).

LOCATION OF MATERIAL.—Holotype, G2.351; paratypes, G2.6626 and G2.1672, Museum of Northern Arizona.

REMARKS.—The material consists of three specimens originally described by Brady (1955), who believed them to be the calcified part of cephalopod mandibles—presumably nautiloids (rhyncholites). Yochelson (1971) has interpreted them correctly as the interior impressions of isolated polyplacophoran valves, assigning them with some question to the genus *Cymatochiton* Dall, 1882. This generic assignment seems proper, considering the fact that these specimens have a general resemblance to the type species of *Cymatochiton—C. loftusianus* (King, 1850). Their relationship to *C.? texanus* Girty, 1909, is difficult to determine on account of the small number and the poor preservation of the valves of both species. Neither *C.? texanus* nor *C.? kaibabensis* has any close relationship to the Permian species that are abundant in strata at the border between the Wolfcampian and the Leonardian formations in the Glass Mountain and equivalent areas of West Texas. *Cymatochiton? kaibabensis,* however, has the same general shape as a large, intermediate, unidentified polyplacophoran valve from the Permian of Palermo, Sicily (Socio Limestone), in the collection of the USNM (loc. no. 755, acc. no. 179820).

### *kindbladensis* Smith *in* Smith and Toomey, 1964, *Paleochiton*

*Paleochiton kindbladensis* Smith *in* Smith and Toomey, 1964: 20–22, pl. 3, fig. 1–14 [type species of *Paleochiton* Smith, 1964, by original designation]. Van Belle 1975*a*:124, pl. 1, fig. 3a–c. Sirenko and Starobogatov 1977:33.

GEOLOGICAL AGE.—Lower Ordovician (Kindblade Formation).

LOCALITY.—USA: Oklahoma, from the lower part of the Kindblade Formation, Mill Creek section, Arbuckle Mts.

LOCATION OF MATERIAL.—Holotype, OU-5211; paratype, OU-5212. Paratype, CAS-12586. Paratype, USNM-144583.

REMARKS.—In the genus *Paleochiton* the intermediate valves are longer than wide, rectangular, with an acute jugal ridge, and straight side-slopes. The dorsal surface is not divided into clearly defined shell areas. It is assigned to the family Gotlandochitonidae, Bergenhayn, 1955. *Paleochiton kindbladensis,* type of the genus, is based on four intermediate valves; the head and tail valves are unknown. The holotype measures: length, 13.4 mm; width, 11.2 mm; height, 5.5 mm; width of apical area, 1.2 mm; the angle of divergence of the side-slopes is 114°. Specimens were acid-etched from limestone blocks and have been much altered during fossilization, only a few major sculptural elements being preserved. The valves were found in association with sponges of the genera *Calathium* and *Archaeoscyphia.*

### *kirkbyanus* (Etheridge, 1882), *Glyptochiton*

*Chitonellus kirkbyanus* Etheridge, 1882:100–101, pl. 2, fig. 14–22.

*Glyptochiton kirkbyanus* (Etheridge). Smith 1971:567, 572.

GEOLOGICAL AGE.—Lower Carboniferous (Main or Hurlet Limestone).

LOCALITY.—Scotland: Ayrshire, Law Quarry near Dalry.

LOCATION OF MATERIAL.—Collections of J. Bennie, J. Armstrong, J. Smith, etc. (fide Etheridge). Present location of type or other specimens unknown.

REMARKS.—This is another of the species belonging under the genus *Glyptochiton* de Koninck, 1883 with *G. cordifer* (de Koninck, 1844) from the Carboniferous of Belgium as the type species. It is well described and illustrated from specimens representing both end valves, intermediate valves, and one presumed to be valve *ii* in position sequence. From the description and illustrations it appears different from *G. subquadratus* (Kirkby and Young, 1867), *G. quadratus* (Etheridge, 1882), and *G. youngianus* (Kirkby and Young, 1867).

Etheridge pointed out that the tail valve illustrated by de Ryckholt (1845, pl. 4, fig. 10) for *Glyptochiton cordifer* closely resembles the tail valve of *G. kirkbyanus.*

### *kirkbyi* (de Koninck, 1883), *Cymatochiton*?

*Chiton* sp. Kirkby, 1862:236, fig. 9–10.

*Rhombichiton kirkbyi* de Koninck, 1883:209–210, pl. 53, fig. 37–41.

GEOLOGICAL AGE.—Lower Carboniferous (Lower Scar) (Kirkby). Tournaisian (de Koninck).

LOCALITIES.—England: Settle, Yorkshire, in the Mountain Limestone (Kirkby). Belgium: Visé (de Koninck).

LOCATION OF MATERIAL.—Unknown.

REMARKS.—Kirkby reported an intermediate valve, found at Settle, Yorkshire, in 1862 but did not name it at the time. It is much wider than long, and he would have identified it as *Chiton loftusianus* King, 1848 had it come from the Permian. It measures: length, 1/5 in. (5 mm); breadth, 6/10 in. (15 mm). The valve is rather high-arched with a mucronate apex and a distinct dor-

sal ridge. The sutural laminae are short and wide; the sutural sinus is shallow and broad.

De Koninck named this valve in 1883, assigning it to his genus *Rhombichiton,* and said it also occurred in the Tournaisian of Visé, Belgium.

### *knighti,* Hoare and Smith, 1984, *Chauliochiton*

*Chauliochiton knighti* Hoare and Smith, 1984:96–97, fig. 8 (reconstruction), 9A–J [type species of *Chauliochiton* Hoare and Smith, 1984, by original designation].

Geological Age.—Lower and Middle Permian (Wolfcampian, Leonardian).

Localities.—USA: Texas, Bone Spring Formation, USNM loc. 725d; Road Canyon Formation, USNM loc. 709c, 721j, 721z, 726d, Glass Mts., West Texas.

Location of Material.—Holotype, USNM-330882; paratypes, USNM-330883–330886.

Remarks.—A reconstructed specimen is approximately 50 mm in length and 15 mm in width with a length to width ratio of 3.3:1. The head and tail valves are unknown. The intermediate valves are highly arched (jugal angle averaging 97°) and strongly swept-wing in shape with a deep jugal sinus and with the apical angle averaging 79°. The jugal ridge is narrow and prominent and the side-slopes slightly convex. A distinct raised lateral area consists of two ridges with the inner ridge bearing several prominent spinose processes. The apical area is large and the sutural laminae are short and broadly rounded, coinciding with the width of the narrow anterior margins. The entire surface is ornamented by closely spaced, flat-topped ridges giving a clapboard appearance.

Average dimensions of the intermediate valves are: length, 9.9 mm; width, 14.7 mm; height, 7.2 mm.

The new genus *Chauliochiton* Hoare and Smith, 1984 was erected to embrace Paleozoic taxa having spinose processes bordering valve margins. "*Chiton*" *geikiei* Etheridge, 1882 has been provisionally assigned to this genus.

### *laevigatus* Roemer, 1855, "*Chiton*"

*Bellerophon expansus*? Sowerby. Roemer 1843:32, pl. 9, fig. 5. Pictet 1845:300.

*Chiton laevigatus* Roemer, 1855:36, pl. 7, fig. 8a–b. de Koninck 1857:196. Baily 1859:333; 1860:95. Rochebrune 1883:24. Clarke 1885:337.

*Chiton* sp. Roemer, 1855:148, pl. 22, fig. 9.

*Chiton sella* Trenkner, 1868:136, pl. 2, fig. 27.

Geological Age.—Upper Devonian.

Locality.—Germany: Grund, Hartz Mts.

Location of Material.—Specimens from Winterberg, Germany, in BM (N.H.) (fide H. W. Ball).

Remarks.—Clarke (1885) furnished the most complete discussion of this species, in which he includes as synonyms *Chiton* sp. Roemer (1855), *C. sella* Trenkner (1868), and fossils identified as *Bellerophon expansus* Sowerby (1839). However, he did not mention Sandberger's and de Koninck's views that the latter was a synonym of *Chiton cordiformis* Sandberger, 1845. Rochebrune (1883) thought *C. laevigatus* was possibly a *Metapoma* (patellid gastropod) and not a polyplacophoran.

Clarke supplied the dimensions of the valves of the species as follows (mm):

| Valve | Length | Width |
|---|---|---|
| Head | 32 | 25 |
| Intermediate* | 14 | 33 |
| Tail | 17 | 20 |

* Type of *Chiton sella* Trenkner, 1868.

### *laterodepressus* (Bergenhayn, 1945), *Proleptochiton*

*Chiton* sp. Etheridge, 1882:91, pl. 1, fig. 16.

*Lepidopleurus laterodepressus* Bergenhayn, 1945:389, text-fig. 1–4. Nicolaus 1963:203, pl. 16, fig. 2a–g; pl. 18, fig. 5.

*Helminthochiton* aff. *gemmatus* Schmidt, 1951:189, pl. 1, fig. 11.

*Proleptochiton laterodepressus* (Bergenhayn). Sirenko and Starobogatov 1977:36 [type species of *Proleptochiton* Sirenko and Starobogatov, 1977, by original designation].

*Rhombichiton laterodepressus* (Bergenhayn). Lang, Marek, and Pek 1982:299–302, pl. 1, fig. 1–10; pl. 2, fig. 1–4. Turek and Prokop 1982:288.

Geological Age.—Lower and Middle Carboniferous (Dinantian, Visean, Namurian).

Localities.—Scotland: Woodmill, Fifeshire, 91.4 m below the Hosir Limestone (Bergenhayn). Czechoslovakia: Myslejovice Formation near Vyškov. Germany: Culm, Rheinisches Schiefergebirge Hills (Lang, Marek, and Pek). Northeastern Spain (Schmidt).

Location of Material.—Bergenhayn's figured specimens (G.23441, G.23446) and other specimens (G.23442, G.24443) in BM (N.H.). Lang, Marek, and Pek figured specimens (SKMG 700–711) are in the collections of the Department of Mineralogy and Geology, Palacký University, Olomouc.

Remarks.—This is a well-marked and distinct species of Paleozoic polyplacophoran. It is based on four well-preserved valves, which represent three animals, one specimen having two adjacent valves. The valves have differentiated shell areas and the dorsal sculpture is granular, of a type

generally similar to species in the genera *Helminthochiton* and *Lepidopleurus.*

Bergenhayn's assignment to the Neoloricata, suborder Lepidopleurina, is obviously correct; but while it also falls in the family Lepidopleuridae, its allocation to the genus *Lepidopleurus* may be questioned. The valves of "*L.*" *laterodepressus* are larger and shaped differently from those of Recent species in the genera (or subgenera) *Lepidopleurus, Leptochiton, Deshayesiella,* and *Beanella.* Moreover, the genus *Lepidopleurus* s.s. is not certainly known earlier than the Pliocene, although recorded from the Eocene of France; nor have any fossil species having any similarity to "*L.*" *laterodepressus* been reported from the Mesozoic. Lacking any better evidence than now is available, it seems unreasonable to assume the occurrence of the genus in its accepted modern sense as far back as the Paleozoic.

Sirenko and Starobogatov (1977), recognizing the differences between *Lepidopleurus laterodepressus* and modern leptochitonids, erected the new genus *Proleptochiton* with *Lepidopleurus laterodepressus* as the type species. They appear to be correct in distinguishing *Proleptochiton* from *Pterochiton* Carpenter *in* Dall, 1882 and the new genus is also distinguishable from *Glaphurochiton* Raymond, 1910.

### *laterodepressus* Bergenhayn, 1955, *Gotlandochiton*

*Gotlandochiton laterodepressus* Bergenhayn, 1955:17–18, pl. 1, fig. 8; pl. 2, fig. 5. Sirenko and Starobogatov 1977:31, fig. 2b.

Geological Age.—Silurian (Gotlandian).
Locality.—Sweden: Grötlingbo; Gansviken.
Location of Material.—Holotype, RM Mo-6020.

Remarks.—This species rests on the inadequate evidence of a single, incomplete intermediate valve estimated to be 8.57 mm long. More specimens should be collected in order to verify its validity.

*Gotlandochiton laterodepressus* Bergenhayn, 1955 should not be confused with *Proleptochiton laterodepressus* (Bergenhayn, 1945).

### *lebescontei* Barrois, 1889, *Euleptochiton*?

*Helminthochiton lebescontei* Barrois, 1889: 181, 182, pl. 15, fig. 15a–c.

Geological Age.—Lower Devonian (Emsian).
Locality.—France.
Location of Material.—Unknown.

Remarks.—A simple intermediate valve is described and illustrated by Barrois (1889). The valve is slightly wider than long, with steep sideslopes and an apical angle of 80°. The sutural laminae are short and broadly rounded. A jugal ridge projects out into the concave anterior margin. The surface is ornamented with "irregularly spaced pleated growth increments," which are more prominent near the margins. The specimen is 12.0 mm long and 14.0 mm wide.

The wide, broadly rounded sutural laminae prevent an assignment to *Gryphochiton* Gray, 1847*a* or to *Helminthochiton* Salter *in* McCoy, 1846. The characteristics of the valve, as well as can be discerned from the description and illustrations of Barrois, appear to best fit those of *Euleptochiton* Hoare and Mapes, 1985*a.* The lack of information concerning the tail valve makes this a questionable assignment.

### *legiacus* (de Ryckholt, 1845), *Pterochiton*

*Chiton legiacus* de Ryckholt, 1845:52, pl. 4, fig. 5–6. Bronn 1848:292. de Koninck 1857:195. Baily 1859:333; 1860:95. Kirkby 1862:237.
*Helminthochiton legiacus* (de Ryckholt). Salter 1847:52.
*Pterochiton legiacus* (de Ryckholt). Dall 1882:281. Sirenko and Starobogatov 1977:36.
*Anthrocochiton legiacus* (de Ryckholt). Rochebrune 1883:28–29.
*Rhombichiton legiacus* (de Ryckholt). de Koninck 1883:208–209, pl. 51, fig. 11–14, 41–42; pl. 52, fig. 18–21.

Geological Age.—Lower Carboniferous.
Locality.—Belgium: Visé.
Location of Material.—Unknown.

Remarks.—Dall included this species in the genus *Pterochiton* Carpenter *in* Dall, 1882, the type species being *P. eburonicus* (de Ryckholt, 1845) from the same locality. It should be noted, however, that Dall based *P. legiacus* on de Ryckholt's original illustrations contained in his plate 4, figures 5–6, and plate 23, figures c–e, but not on plate 23, figures a–b.

While both de Koninck (1857) and Baily (1859) list de Ryckholt's species as a subspecies of *Chiton gemmatus* de Koninck, 1844 [=*C. subgemmatus* d'Orbigny, 1850], they considered it to be conspecific with *C. gemmatus* at that time, although later de Koninck (1883) included it under his genus *Rhombichiton.*

### *loftusianus* (King, 1850), *Cymatochiton*

*Chiton* sp. King, 1844:382. King 1846:10. Howse 1848:242.

*Chiton*? spec. nov. Kirkby, 1862:235–236. Rochebrune 1883: 35.

*Helminthochiton* sp. (King). Salter 1847:51 (footnote).

*Chiton loftusianus* King, 1848:12 (nomen nudum?). King 1850: 202–203, pl. 16, fig. 9–14. Roemer *in* Bronn 1854:447. Howse 1857:463–464. de Koninck 1857:193, 195. Howse 1858: 244, 271–272. Kirkby 1859:607, 611–615, pl. 16, fig. 31–41. Baily 1859:333; 1860:94. Kirkby 1860:243–248, pl. 13, fig. 31–41; 1864:216. Kirkby and Young 1867:340–341, pl. 16, fig. 17. Etheridge 1882:89. Yochelson 1971:131.

*Protalochiton loftusianus* (King). Rochebrune 1883:3, 8, 36–37.

*Cymatochiton loftusianus* (King). Dall 1882:282 [type species of *Cymatochiton* Dall, 1882 by original designation]. Tryon 1883:340, pl. 85, fig. 68–69. Branson 1948: 761. Smith 1960: I54, fig. 36,6a–f (ex King 1850). Yochelson 1971:132. Van Belle 1975*b*: 137, pl. 2, fig. 3a–b. Sirenko and Starobogatov 1977:35, fig. 1g, h.

Geological Age.—Permian (Magnesian Limestone). Upper Carboniferous (Orchard Limestone?).

Localities.—England: Durham, shell limestone of Tunstall Hill (King); Humbleton Hill, Hylton Castle, and at the New Poorhouse, Bishopwearmouth (Kirkby); Claxheugh, Ryhope, Silksworth, and Southwick Red House (Howse). Scotland: Williamwood, near Glasgow, in shales of the Orchard Limestone.

Location of Material.—Specimen from Williamwood in the collection of J. Bennie (fide Etheridge). Specimens in BM (N.H.) (fide H. W. Ball).

Remarks.—The illustrations show this to be a valid polyplacophoran species. The intermediate valves having a swept-wing appearance with a pointed apex, a rather prominent jugal ridge, and excavated anterolateral margins. The sutural laminae are small and semicircular. The valves measure approximately 12 mm long and 6 mm wide. End valves are generally semicircular in shape, with rounded margins; the mucro on the tail valve is near the posterior margin. (It should be mentioned that King's original illustrations of the valves of *C. loftusianus* [see Smith 1960, p. I53, figs. 36, 6a–f] do not indicate the presence of sutural laminae in the intermediate and tail valves, and the head and tail valves are reversed in position.)

In discussing polyplacophoran valves from the Permian, Howse (1857) said he thought several species were included and doubted whether King's description and illustrations were correct. The species has been reported from several localities in addition to the Permian of Tunstall Hill, the type locality. Kirkby (1859) mentioned and illustrated an intermediate valve from the Carboniferous Lower Scar, Yorkshire, England. Etheridge (1882) cited a single intermediate valve from Williamwood, near Glasgow, Scotland, in the Upper Carboniferous shale of the Orchard Limestone. Branson (1948) reported it from Germany as well as England.

Kirkby (1859:613) covered the species in considerable detail. His account adds materially to an understanding of its characters. He had adequate material for study as he says "out of ninety-one plates which I have obtained at Tunstall Hill, sixty-three belong to the short, transverse type [=*C.*? *cordatus* Kirkby, 1859], and fourteen to the more elongate type [=*C. loftusianus*]."

Kirkby (1862:235–236, fig. 7–8) lists *Chiton*? sp. nov. based on a single shield-shaped plate, longer than wide, with no indication of sutural laminae. The side view shows a projecting, pointed apex. The jugal ridge is rather well-developed, the lateral areas are weakly defined, and the dorsal surface is coarsely granulated in a concentric pattern following the faint lines of growth. Measurements are: length, $^4/_{10}$ in. (10 mm); breadth, $^7/_{20}$ in. (9 mm). Kirkby said it resembled *Chiton barrandeanus* de Ryckholt, 1852, from the Carboniferous of Visé, Belgium, but considered it to be different specifically. Later, in 1867, Kirkby and Young identified this plate as *C. loftusianus*. It should be noted that this valve is not *Chiton* sp. nov.? described and illustrated by Kirkby in 1862 (p. 236, fig. 9–10), which was renamed later as *Chiton kirkbyi* by de Koninck, 1883.

### *longissimus* Bergenhayn, 1955, *Chelodes*

*Chelodes longissimus* Bergenhayn, 1955:14–15, pl. 1, fig. 5. Sirenko and Starobogatov 1977:31.

Geological Age.—Ordovician (Middle Bala).
Locality.—Scotland: Shalloch Mill.
Location of Material.—Holotype, BM (N.H.) G-47174.

Remarks.—The species is based on a single, heart-shaped, intermediate valve 14 mm long and 8 mm wide. It is high-arched, with a well-developed saddle. Bergenhayn compared it with *Chelodes gotlandicus* Lindström, 1884.

### *mempiscus* (de Ryckholt, 1845), *Gryphochiton*

*Chiton mempiscus* de Ryckholt, 1845:48–50, 62, pl. 2, fig. 5–8. Bronn 1848:292. de Koninck 1857:196. Baily 1859:333; 1860:95. Kirkby 1862:237. Bigsby 1878:319.

*Gryphochiton mempiscus* (de Ryckholt). Dall 1882:280. Rochebrune 1883:25–26. Sirenko and Starobagatov 1977: 35.

*Helminthochiton mempiscus* (de Ryckholt). Salter 1847:52. de Koninck 1883:202–203, pl. 50, fig. 23, 31. Smith 1960:152.

Geological Age.—Lower Carboniferous.
Locality.—Belgium: Tournai.

LOCATION OF MATERIAL.—PSM (fide Rochebrune). On exhibit in Paleontological Museum, Paris (fide G D. Hanna).

REMARKS.—This appears to be a valid polyplacophoran species although Rochebrune (1883) thought it to be conspecific with *Gryphochiton priscus* (Münster, 1839).

### *mirabilis* (Butts, 1926), *Chelodes*?

*Priscochiton*? *mirabilis* Butts, 1926:100, pl. 18, fig. 30–31.
*Chelodes*? *mirabilis* (Butts). Smith *in* Smith and Toomey, 1964: 14–15.

GEOLOGICAL AGE.—Lower Ordovician (Odenville Limestone).
LOCALITY.—USA: Alabama, about 1.6 km SW of Hebron Church, 8 km SW of Leeds.
LOCATION OF MATERIAL.—Holotype, USNM-71467.

REMARKS.—The holotype exhibits all the characters of the genus *Chelodes,* to which it is referred provisionally. It measures (in mm): length, 22.8; width, 17.3; height, 13.0; overhang of apex equivalent to the apical area, 10.0. Butts stated that valves were fairly abundant at the type locality.

### *mosensis* (de Ryckholt, 1845), *Pterochiton*?

*Chiton mosensis* de Ryckholt, 1845:50, pl. 1, fig. 10. Bronn 1848:292. de Koninck 1857:195. Baily 1859:333; 1860:95. Bigsby 1878:319. Rochebrune 1883:32.
*Helminthochiton*? *mosensis* (de Ryckholt). Salter 1847:52.
*Rhombichiton mosensis* (de Ryckholt). de Koninck 1883:206, 207.

GEOLOGICAL AGE.—Lower Carboniferous.
LOCALITY.—Belgium: Visé.
LOCATION OF MATERIAL.—Unknown.

REMARKS.—Both de Koninck and Baily originally thought *Chiton mosensis* was a variety of *C. gemmatus* de Koninck, 1844 [=*C. subgemmatus* d'Orbigny, 1850], although later, in 1883, de Koninck placed it in his new genus *Rhombichiton* as a junior synonym of *R. gemmatus* (de Koninck, 1883). Dall (1882) curiously omits any mention of *C. mosensis.*

Pending further study of the type and related material, *Chiton mosensis* would appear to be acceptable as a valid polyplacophoran in spite of Rochebrune's doubt on this point. Proper generic placement must await additional study, but *Chiton mosensis* appears to have characteristics similar to those of *Pterochiton* Carpenter *in* Dall, 1882.

### *mucronatus* (de Koninck, 1883)

*Helminthochiton mucronatus* de Koninck, 1883:204, pl. 51, fig. 19–22, 33–35.
See: *priscus* Münster, 1839.

GEOLOGICAL AGE.—Lower Carboniferous.
LOCALITY.—Belgium: Tournai.
LOCATION OF MATERIAL.—Specimens in BM (N.H.) Department of Geology (fide H. W. Ball).

REMARKS.—The specimens of this species, as illustrated and described by de Koninck (1883), are little different from those of *Gryphochiton coarctatus* (de Koninck, 1883) or *G. priscus* (Münster, 1839). It appears that the specimens of all three illustrate a normal variation and that the two former species should be considered synonyms of *G. priscus.*

### *nervicanus* (de Ryckholt, 1845), *Gryphochiton*

*Chiton nervicanus* de Ryckholt, 1845:47, 62, pl. 1, fig. 7–9. Bronn 1848:292. de Koninck 1857:196. Baily 1859:333; 1860:95. Kirkby 1862:237.
*Helminthochiton nervicanus* (de Ryckholt). Salter 1847:52. de Koninck 1883:203, pl. 52, fig. 30–33; pl. 53, fig. 8–11.
*Gryphochiton nervicanus* (de Ryckholt). Gray 1847*a*:70 [type species of *Gryphochiton* Gray, 1847*b*, by monotypy]. Herrmannsen 1852:58. Dall 1882:280. Rochebrune 1883:25. Sirenko and Starobogatov 1977:35.

GEOLOGICAL AGE.—Lower Carboniferous.
LOCALITY.—Belgium: Tournai.
LOCATION OF MATERIAL.—PSM (fide Rochebrune). BM (N.H.) (fide H. W. Ball). Specimens on exhibit, Paleontological Museum, Paris (fide G D. Hanna).

REMARKS.—Rochebrune considered this species to be the same as *Chiton priscus* Münster, 1839 although both de Koninck and Baily listed it as a separate species.

### *newelli* Smith, 1976. *Pterochiton*

*Pterochiton newelli* Smith, 1976:285–286, fig. 29–34. Sirenko and Starobogatov 1977:36.

GEOLOGICAL AGE.—Middle Permian.
LOCALITY.—USA: Texas. Type locality: "USNM Loc. 726-d; small *Leptodus* bed at 1484 m elevation, 2.194 km, south 4° west of Willis ranch, and 1.565 km, north 68° east of Hill 5801, Hess Canyon quadrangle, Texas" (Smith 1976).
LOCATION OF MATERIAL.—Holotype, USNM-211133; paratypes, USNM-211134-211139.

REMARKS.—This species from the West Texas Permian is related to *Pterochiton arthurcooperi* Smith, 1976 although it is much smaller in size. Measurements are (mm):

| | Intermediate valves | | Tail valve |
|---|---|---|---|
| | Holotype | Another | |
| Length | 6.2 | 5.4+ | 3.7+ |
| Width | 5.9 | 7.1 | 4.4 |
| Height | 3.3 | 3.0 | 2.0 |

Contributing to the separation of this species from *P. arthurcooperi* is the fact that no valves of the latter were recovered from locality 726-d, the type and so far the only locality for *P. newelli.*

### *occidentalis* Foster, 1837. Genus *incertae sedis*

*Chiton occidentalis* Foster, 1837:82–84, fig. 20.

GEOLOGICAL AGE.—Pennsylvanian.
LOCALITY.—USA: Ohio. Limestone in the bed of the Muskingum River just below the falls at Zanesville (Foster).
LOCATION OF MATERIAL.—Unknown.

REMARKS.—From the description and illustration provided by Foster (1837) this specimen appears to be an incomplete internal mold of a nautiloid cephalopod. It is here discounted as a polyplacophoran.

### *ochtinensis* (Turek and Prokop, 1982), *Proleptochiton*

*Rhombichiton ochtinensis* Turek and Prokop, 1982:288–290, pl. 2, fig. 1–2, text-fig. 2.

GEOLOGICAL AGE.—Middle Carboniferous (Namurian A).
LOCALITY.—Quarry northwest of the village of Ochtiná in the Spišsko-gemerské Rudohorie Mts., Czechoslovakia.
LOCATION OF MATERIAL.—Holotype (reg. no. S2205) in the collections of the Paleontological Department, National Museum, Prague.

REMARKS.—This species is based upon an articulated specimen of all eight valves. The valves are slightly disturbed in position and the sutural laminae are not observable. Turek and Prokop believe that this species is closely related to *Proleptochiton laterodepressus* (Bergenhayn, 1945) but differs in being smaller, having coarser sculpture, and less defined medial areas. The specimen is 9.5 mm long and approximately 3.5 mm wide.

The reconstruction of the outline of the tail plate in text-figure 2 appears to be incomplete and based only upon the exposed portion of the plate in this specimen. The anterior margins could not be so posteriorly divergent in relation to the shape of the posterior margins of the reconstructed intermediate valves.

### *oklahomensis* Smith *in* Smith and Toomey, 1964, *Ivoechiton*

*Ivoechiton oklahomensis* Smith *in* Smith and Toomey, 1964: 22–23, pl. 4, fig. 1–15. Van Belle 1975*a*, pl. 1, fig. 9a–b.

GEOLOGICAL AGE.—Lower Ordovician (Kindblade Formation).
LOCALITY.—USA: Oklahoma, from the lower part of the Kindblade Formation, Mill Creek section, Arbuckle Mts.
LOCATION OF MATERIAL.—Holotype, OU-5219; paratypes, OU-5220, 5221. Paratypes, USNM-144534, 144535. Paratypes, CAS-12587, 12588.

REMARKS.—The species is based on seven intermediate valves, no end valves having been found. The preservation is poor. It has been referred to the genus *Ivoechiton* from the Upper Cretaceous of Sweden solely because of its general valve shape and configuration, an assignment that must remain provisional until better-preserved specimens can be collected.

### *onerosus,* Hoare and Smith, 1984, *Stegochiton*?

*Stegochiton*? *onerosus* Hoare and Smith, 1984:99, fig. 10J–M.

GEOLOGICAL AGE.—Lower Permian (Wolfcampian).
LOCALITY.—USA: Texas, Hess Formation, USNM loc. 709d, Glass Mts., West Texas.
LOCATION OF MATERIAL.—Holotype, USNM-330888; paratypes, USNM-330889–330891.

REMARKS.—This species is based upon intermediate valves which in general shape are close to that of *Stegochiton coxi* Hoare and Smith, 1984. *Stegochiton*? *onerosus* differs in being very thick-valved with much larger, subtrapezoidal sutural laminae projecting as extensions of the anterolateral margins, and an ornamentation of closely spaced pustules arranged in a quincunx pattern. Measurements of a valve are (mm): length, 15.1; width, 15.0; height, 10.8.

### *orbiculus* Trenkner, 1868, "*Chiton*"

*Chiton orbiculus* Trenkner, 1868:136, pl. 2, fig. 28. Clarke 1885:339, pl. 4, fig. 14–15.

GEOLOGICAL AGE.—Upper Devonian.
LOCALITY.—Germany: Winterberg, Hartz Mts.
LOCATION OF MATERIAL.—Unknown.

REMARKS.—Clarke believed this species to be a synonym of "*cf. Chiton priscus* Münst., de Koninck . . . [1883], tome VIII, t. 53, f. 26–28." He gives its dimensions as 14 mm long and 16 mm wide.

*pannuceus,* Hoare and Mapes, 1985*b*, *Acutichiton*

*Acutichiton pannuceus* Hoare and Mapes, 1985*b*:1324–1326, fig. 1.1–1.15.

GEOLOGICAL AGE.—Upper Pennsylvanian (Virgilian).

LOCALITY.—USA: Texas, Finis Shale exposed in gullies south of dam, 0.4 km east of Hwy. 59 and 8.3 km NE of Jacksboro, Jack Co., Texas. Cundiff 7½-minute Quadrangle.

LOCATION OF MATERIAL.—Holotype, OSU-36976; paratypes, OSU-36971–36975.

REMARKS.—This small, thick-valved species (~25 mm long) is based upon one tail, two head, and four intermediate valves. The head valve is semicircular in shape with convex slopes and only slightly mucronate. The intermediate valves are highly arched, slightly wider than long, mucronate, with a moderate jugal sinus, and large apical areas. Distinct lateral areas are raised above the central areas and marked by pronounced growth rugosities and finer granulose ornamentation. The sutural laminae are relatively narrow and bluntly rounded anteriorly. The tail valve is triangular in shape with a narrow jugal ridge ending in a terminal mucro. The posterior area is defined by coarse growth rugosities which extend onto the ventral hypotyche. The sutural laminae are narrow, thick, and broadly rounded. Surface ornamentation is of granules which are finer on the lateral areas than on the central areas of the intermediate valves and on the posterior area of the tail valve.

Average dimensions are (mm):

| | Head | Intermediate | Tail |
|---|---|---|---|
| Length | 2.3 | 4.3 | 5.3 |
| Width | 5.2 | 5.4 | 3.8 |
| Height | 2.2 | 2.7 | 2.6 |

*papilio* (Whidborne, 1892), *Pterochiton*

*Helminthochiton papilio* Whidborne, 1892:333–335, pl. 31, figs. 15, a, b, 16.

GEOLOGICAL AGE.—Devonian.

LOCALITY.—England: Wolborough and Lummaton (Whidborne, 1892).

LOCATION OF MATERIAL.—Figured specimen (15, a, b) in the Museum of Practical Geology, London. Figured specimen (16) in Whidborne's private collection (fide Whidborne).

REMARKS.—It is possible that Whidborne (1892) has included two different species under this designation. Figure 16 shows an entirely different intermediate valve shape than figures 15, a, b and it is the latter upon which the description of the species is based. He had some doubt as to the biological affinity of the specimen from Lummaton although it has the general shape of the valve illustrated by Barrois (1889) as *Helminthochiton lebescontei.*

The specimen as described and illustrated possesses very large sutural laminae which are apparently striated, excavated anterolateral margins, a projecting anterior margin between the sutural laminae, an acuminate posterior margin and steep side-slopes. An ornamentation of oblique, raised ridges may be present. The specimen is 16.0 mm long, 14.0 mm wide, and 10.0 mm high.

On the basis of the characteristics as described and illustrated we are placing this species in the genus *Pterochiton* Carpenter *in* Dall, 1882.

*parallelus,* DeBrock, Hoare, and Mapes, 1984, *Coryssochiton*

*Coryssochiton parallelus* DeBrock, Hoare, and Mapes, 1984: 1127–1129, fig. 2G, H; 6A–O [type species of *Coryssochiton* DeBrock, Hoare, and Mapes, 1984, by original designation].

GEOLOGICAL AGE.—Middle Pennsylvanian (Desmoinesian).

LOCALITY.—USA: Texas, Lazy Bend Formation exposed on a small tributary to Kickapoo Creek, 30 m N of where Farm to Market Road 1189 crosses Rocky Branch, approximately 8.5 km NE of Lipan and 0.75 km S of Kickapoo Falls, Hood Co. Dennis 7½-minute Quadrangle.

LOCATION OF MATERIAL.—Holotype, OSU-36930; paratypes, OSU-36931–36939 and BGSU-4229.

REMARKS.—A reconstructed specimen is about 22 mm long with a length to width ratio of 3.5: 1. The head valves are broadly rounded, about twice as wide as long, with a nearly straight posterior margin, slightly mucronate, and straight side-slopes. The intermediate valves are low, subrectangular with nearly parallel anterior and posterior margins, rounded lateral margins, slightly mucronate (apical angle averages 126°), and broadly rounded sutural laminae. Tail valves are strongly arched with steep side-slopes, with a sharply rounded posterior margin, mucro located above posterior margin, and broadly rounded sutural laminae. All valves are exceptionally thick. The valve surfaces are ornamented with rows of very fine granules paralleling the anterior and lateral margins.

Average dimensions are (mm):

| | Head | Intermediate | Tail |
|---|---|---|---|
| Length | 2.8 | 3.1 | 3.2 |
| Width | 5.7 | 6.1 | 3.4 |
| Height | 1.7 | 1.8 | 1.8 |

The new genus *Coryssochiton* was erected to include taxa having thick valves, subrectangular intermediate valves lacking division into areas, and highly arched tail valves with the mucro located above the posterior margin. The sutural laminae are broadly rounded, not extending to the anterolateral corners.

*parvus* (Stevens, 1858), *Gryphochiton*

*Chiton parvus* Stevens, 1858:264.
*Anthrocochiton parvus* (Stevens). Rochebrune 1883:30.
*Gryphochiton? parvus* (Stevens). Cumings 1906:1365–1366, pl. 24, fig. 8, 8a–c.
*Helminthochiton parvus* (Stevens). Yochelson and Saunders 1967:12.
*Glaphurochiton parvus* (Stevens). Sirenko and Starobogatov 1977:36.
*Pterochiton parvus* (Stevens). Kues 1978:305–308, pl. 1, fig. 1–9; pl. 2. fig. 1, 2, 4–7, 9. Hoare and Sturgeon 1979:178, pl. 2, fig. 4–6.

Geological Age.—Middle Mississippian (Meramecian).

Localities.—USA: Indiana, Bergen Hill (later corrected to Spergen Hill) (Stevens); also Elletsville, Stinesville, Ramona, and Cleveland quarry near Harrodsburg (Cumings; Kues).

Location of Material.—Neoholotype, IU 1033-1; neoparatypes, IU 1033-2, 1669, 1669-B, 8130-1, 13882, 13885, 13890 in the Department of Geology, Indiana University, Bloomington; neoparatypes, USNM-244959–244961. Neoparatypes, UNM-3130, 3131, in the Department of Geology, New Mexico University, Albuquerque. Specimens in Department of Paleontology, University of California (Berkeley), no. 1639.

Remarks.—This species belongs in the genus *Gryphochiton* Gray, 1847*a*. Cumings said Steven's species agrees with specimens in the Indiana University Collection from the Salem Limestone of Harrodsburg, Indiana. Kues (1978) selected the neoholotype from the Harrodsburg locality.

Valves of *Gryphochiton parvus* are much smaller than those of *Glaphurochiton carbonarius* (Stevens, 1858) from the Pennsylvanian of Illinois, Missouri, and Pennsylvania. It is a valid species with, apparently, a fairly limited geographic distribution in the United States.

*patelliformis* Etheridge, 1882.
Genus *incertae sedis*

*Chitonellus*(?) *patelliformis* Etheridge, 1882:98–99, pl. 1, fig. 17; pl. 2, fig. 8–9.

Geological Age.—Lower Carboniferous (Main or Hurlet Limestone).

Locality.—Scotland: Ayrshire, Law Quarry, near Dalry (Etheridge).

Location of Material.—Collections of J. Bennie, J. Armstrong, J. Smith, etc. (fide Etheridge). Present location unknown.

Remarks.—This species is based on what is thought to be a head valve, ovate in shape, with a patelliform apex situated anterior to the center of the valve. From this apex, at least seven strong, diagonal ribs radiate to the anterior valve margin, crenulating the valve edge; also, two strong, diagonal grooves radiate posteriorly with a narrowly triangular, raised, rounded dorsal area between them. The valve appears to have an articulamentum consisting only of a narrow rim around the valve margins. There is no evidence of the occurrence of sutural laminae on one specimen (Etheridge 1882, pl. 2, fig. 8–9), although in another (pl. 1, fig. 17), a possible tail valve, the presumed articulamentum area, which is rather wide and extends anteriorly, terminates in two rounded projections with a broad, square, shallow sinus between them.

Related species are *Chitonellus antiquus* (Howse, 1848), *C. bennieanus* Etheridge, 1882, *C. subantiquus* Kirkby and Young, 1867, and possibly *C. distortus* Kirkby, 1859, the latter species from the British Permian. The general remarks relating to *C. bennieanus* apply equally well to *C. patelliformis* and the species is here rejected as a polyplacophoran.

*priscoides* (Carpenter *in* Dall, 1882), *Gryphochiton*

*Helminthochiton priscoides* Carpenter *in* Dall, 1882:280. Nomen nudum.

Geological Age.—Devonian.

Locality.—Germany: Vilmar, in Hesse Nassau (Prussia), 12.9 km SW of Weilberg.

Location of Material.—MCZ (Schultze Collection).

Remarks.—*Helminthochiton priscoides* was merely listed by Dall, based on specimens in the MCZ, Cambridge. These specimens, with others in the Schultze Collection were loaned for study through the courtesy of Dr. Harry B. Whittington, and a manuscript report was prepared, which is unpublished. The Schultze Collection lots are accompanied by labels in P. P. Carpenter's handwriting and initials. The specimens of *H. priscoides* represent a tail valve and a head valve, according to Carpenter, whose label reads: "Sent with *Chiton corrugatus* Sand. teste Schultze but not congeneric. Devonian. Vilmar. *Helminthochiton priscoides* Cpr. (type)."

The supposed head valve is flattish, rather thin in texture, with a more or less interrupted concentric sculpture. It is not complete, especially at the posterior edge. It measures (in mm): length, 18.8; width, 16.1; and height, about 7.0. The back is rounded, with straight side-slopes, and a slightly convex aspect in a longitudinal view. Internally there is a strong V-shaped ridge parallel with the posterior valve edges and about 4.5 mm in from these edges.

The supposed tail valve seems, without much doubt, to be one. It is high and bluntly carinate, although somewhat crushed in on the right side. The side-slopes are very steep and straight. Longitudinally, the blunt mucro is prominent, with the posterior edge sloping away sharply at first and less so toward the posterior margin. Sculpture is somewhat similar to that occurring on the supposed head valve.

*Gryphochiton priscoides* is a nomen nudum as of Dall (1882:280). Until intermediate valves can be found that can be definitely associated with the two available specimens, one would hesitate to consider it a valid species although they appear to be different from any other Paleozoic polyplacophorans so far described.

### *priscus* (Münster, 1839), *Gryphochiton*

*Chiton priscus* Münster, 1839:38, pl. 13, fig. 4. de Koninck 1842:321–322, pl. 23, fig. 1a–d. de Ryckholt 1845:56, 62, pl. 3, fig. 1–9. Geinitz 1846:389. Salter 1847:49, 52, fig. 2. Bronn 1848:292. d'Orbigny 1850, vol. 1:127. Quenstedt 1852: 445. Quenstedt 1882:681. Roemer *in* Bronn and Roemer 1851:447, pl. 3, fig. 18. de Koninck 1857:192, 196. Chenu 1859:379, fig. 2852. Baily 1859:333; 1860:95. Eichwald 1860: 1093. Kirkby 1862:237. Roemer 1876, atlas, pl. 45, fig. 22. Bigsby 1878:319. Rochebrune 1883:2, 9. Fraas 1910:83, fig. 55.

*Chiton* (*Gryphochiton*) *priscus* Münster. von Zittel 1924:436, fig. 803.

*Gryphochiton priscus* (Münster). Dall 1882:280 [non] type species of *Gryphochiton* Gray, 1847*a*. Rochebrune 1883:25–26. Tryon 1883:339, pl. 85, fig. 70. Simroth *in* Bronn 1893: 311, fig. 37. Stromer von Reichenbach 1909, fig. 230. Pompeckj 1912, fig. 1A. Quenstedt 1932:86. Moore, Lalicker, and Fischer 1952:272, fig. 3. Dechaseaux *in* Piveteau 1952, fig. 3. Sirenko and Starobogatov 1977:35, fig. 1i, j.

*Chiton* (*Helminthochiton*) *priscus* Münster. von Zittel 1885, fig. 209.

*Helminthochiton mucronatus* de Koninck, 1883:204, pl. 51, fig. 19–22, 33–35.

*Helminthochiton coarctatus* de Koninck, 1883:201–202, pl. 50, fig. 33–36.

*Helminthochiton priscus* (Münster). Salter 1847:49, 52, fig. 2. de Koninck 1883:199–200, pl. 50, fig. 37, 48; pl. 51, fig, 36; pl. 53, fig. 21, 29. Richardson 1956:62. Smith 1960:I52–I53, fig. 36,2a–b (ex de Koninck, 1883). Fischer 1957:11–12. Eberzin 1960:15–17, fig. 1. Nicolaus 1963:203, pl. 16, fig. 2a–g. Van Belle 1975*b*:136, pl. 2, fig. 1a–b.

GEOLOGICAL AGE.—Lower Carboniferous.

LOCALITY.—Belgium: Tournai. ". . . mergligen Lagerns des jungen vebergans-Kalk von Tournay" (Münster 1839); ". . . à Tournay, dans l'argile subordonée au système anthraxifère supérieur; elles sont rare dans le calcaire même" (de Ryckholt 1845).

LOCATION OF MATERIAL.—PSM (de Koninck Collection) (fide P.-H. Fischer). USNM-63400. MCZ (Schultze Collection). Valves on exhibit in the Paleontological Museum, Paris (fide G D. Hanna).

REMARKS.—*Gryphochiton priscus* has been the most frequently mentioned of all Paleozoic species. This frequency of record may be because the valves are usually well preserved, or because such specimens have been collected with all eight valves in place, which is a situation of rare occurrence. Also, it is possible with sufficient material to make a hypothetical assembly of all valves, which when cemented together, provide a realistic combination.

The set of valves in the USNM, which is cited above, comes from Tournai, the type locality. It consists of a presumed series of eight valves of which the first six have been glued together in a presumably normal overlapping position; valves *vii* and *viii* are separate and are cemented one on top of the other by the original matrix. In addition, there is a separate head valve, 16 mm wide and 9.7 mm long, and a separate intermediate valve, 17.3 mm wide, 15.6 mm long, and 8.8 mm high. Comparison of all these valves with a somewhat comparable series of *Gryphochiton coarctatus* (de Koninck, 1883), also in the USNM, reveals no important differences. Thus, unless compelling reasons can be advanced for indicating a different assignment, *Helminthochiton coarctatus* should, for the present, be placed as a synonym of *H. priscus.*

The synonymy of *Gryphochiton priscus* (Münster, 1839) has been somewhat confused by the fact that Guido Sandberger (1842) also named a *C. priscus* from the Middle Devonian of Vilmar, Germany, which de Ryckholt renamed *Chiton sandbergianus* in 1845. Dall (1882) designated *C. priscus* (Münster, 1839) as the type species of the genus *Gryphochiton* Gray, 1847*a* apparently overlooking the fact that Gray had already designated *Chiton nervicanus* de Ryckholt, 1845 as the type of his genus (1847*a*). Rochebrune (1883) placed *Chiton nervicanus, C. mempiscus* de Ryckholt, 1845, and *C. turnaci-*

*anus* de Ryckholt, 1845 as synonyms of *C. priscus,* but no subsequent reviewer has accepted this assignment.

Specimens under the name of *Helminthochiton priscus* from Cork, Flintshire, and Eire, are in the BM (N.H.) (fide H. W. Ball) but it would appear advisable to compare the material with properly identified valves from the type locality to make sure they are actually the same species. Eichwald (1860) said that *H. priscus* has been found in "l'étage inf. de Borowitchi," on the banks of the Priksha River in Russia. This identification also needs confirmation even though Eichwald has said that the specimen, which is in the collection of the Institute of Mines, Leningrad, is quite complete and easily identified as the same species from the Carboniferous of Belgium.

*priscus* Sandberger, 1842

*Chiton priscus* Sandberger, 1842:399. de Koninck 1857:196. Baily 1859:333.
See: *Chiton sandbergianus* de Ryckholt, 1845.

REMARKS.—Realizing that Sandberger's name was preoccupied by *Chiton priscus* Münster, 1839 de Ryckholt renamed it.

*procumbens* (de Koninck, 1883), *Gryphochiton*

*Helminthochiton procumbens* de Koninck, 1883:204–205, pl. 51, fig. 45–48.

GEOLOGICAL AGE.—Lower Carboniferous.
LOCALITY.—Belgium: Tournai.
LOCATION OF MATERIAL.—Unknown.

REMARKS.—Although de Koninck described both intermediate and tail valves of this species, only the former are illustrated. The intermediate valves are subtriangular in shape with the lateral margins curving into convex posterior margins so that there is a continuous curve from the anterolateral area to the apex. There is a distinct jugal sinus and the sutural laminae are relatively short and blunt. The possible tail valve is described as wider than long, subelliptical in shape and with a jugal carina extending less than two-thirds the valve length, being raised above the valve surface. The subtriangular shape of the intermediate valves appears to be distinctive from *Gryphochiton priscus* (Münster, 1839) and other species of this genus and the description of the tail valve appears to be more like that of a *Pterochiton* than a *Gryphochiton.*

*productus* Bergenhayn, 1960, *Preacanthochiton*

*Preacanthochiton productus* Bergenhayn, 1960:173, fig. 7–8.

GEOLOGICAL AGE.—Upper Cambrian (Van Buren and Eminence formations).
LOCALITY.—USA: Missouri, Washington County, near the top of the south slope of a hill, 8 km S of Potosi, on the Caledonia Road (Van Buren Formation); Shannon County, ~1 m above the porphyry, Jerktail Mine, head of a small tributary of Thompson Creek, 11.3 km NE of Eminence, NE¼, sec. 5, T 29N, R 3W (low in the Eminence Formation).
LOCATION OF MATERIAL.—Holotype, USNM-137373, plus additional specimens.

REMARKS.—This species is based on three tail valves and two fragments, also believed to be tail valves by Bergenhayn.

Comments on *Preacanthochiton cooperi* Bergenhayn, 1960 and *P.* aff. *cooperi* Bergenhayn, 1960, described at the same time, apply equally as well to *P. productus.* The collection of tail valves only, while possible, seems a bit unusual.

*pyrmidalus* Hoare, Sturgeon, and Hoare, 1972, *Acutichiton*

*Acutichiton pyrmidalus* Hoare, Sturgeon, and Hoare, 1972:679–680, pl. 3, fig. 15–22 [type species of *Acutichiton* Hoare, Sturgeon, and Hoare, 1972, by original designation]. Hoare and Sturgeon 1976:841, pl. 2, fig. 1–3. Hoare and Sturgeon 1979:179–180, pl. 1, fig. 1–3; pl. 3, fig. 2. Van Belle 1978: 66. Hoare, Mapes, and Atwater 1983, fig. 1A, 2D, E, 3C, D, 4Q, R. DeBrock, Hoare, and Mapes 1984:1132–1134, fig. 9A–W.

GEOLOGICAL AGE.—Middle Pennsylvanian (Desmoinesian).
LOCALITY.—USA: Ohio. Vanport Shale. Abandoned drift mine, S center sec. 24, T 8N, R 16W, Mulga Quadrangle, Milton Tp., Jackson Co. and also in the Lower Mercer Shale in Ohio. Texas, in the Lazy Bend Formation. Small tributary of Kickapoo Creek, 30 m north of crossing of Farm to Market Road 1189 and Rocky Branch, approximately 8.5 km NE of Lipan and 0.75 km south of Kickapoo Falls, Hood Co., Texas. Dennis 7½-minute Quadrangle.
LOCATION OF MATERIAL.—Holotype, OSU-27158; paratypes, OSU-27159–27165. Paratypes, BGSU-2744.

REMARKS.—This species is based on a number of intermediate and tail valves, no head valves having been collected from the type locality. Measurements (length × width) of the largest intermediate valve are 2.6 × 5.4 mm, and of the largest tail valve, 3.8 × 3.8 mm. It is the first-described species in the genus *Acutichiton* Hoare, Sturgeon, and Hoare, 1972, characterized by its fine granular sculpture with intermediate valves wider than long and lacking a jugal sinus, or having a very shallow one; the tail valves are triangular with keeled jugal areas, a terminal mu-

cro, and a large hypotyche. A reconstructed animal has an estimated length of 21 mm and a width of 4–5 mm. Specimens of *Acutichiton pyrmidalus* from the Lazy Bend Formation of Texas closely agree with those from Ohio but attain a larger size. The head valves are semicircular with steep anterior and lateral slopes, a small apex, and a large apical area ventrally.

### *quadratus* (Etheridge, 1882), *Glyptochiton*

*Chitonellus* sp. indet., Etheridge, 1882:97–98, pl. 2, fig. 6–7.
*Chitonellus quadratus* Etheridge, 1882:98.
*Glyptochiton quadratus* (Etheridge). Smith 1971:567, 572.

Geological Age.—Lower Carboniferous (Main or Hurlet Limestone).

Locality.—Scotland: from the Law Quarry near Dalry, Ayrshire (Etheridge).

Location of Material.—Collection of J. Bennie (fide Etheridge). Present location unknown.

Remarks.—This species is closest to *Chitonellus subquadratus* Kirkby and Young, 1867 from the same area. The illustrations show a similar type of valve, almost square instead of rectangular. Other differences between the two species, as given by Etheridge, seem relatively minor; he said he thought the two might be conspecific but "if further researches should prove it distinct it might be called *C. quadratus*" (Etheridge 1882:98).

The species is another to be listed under the genus *Glyptochiton* de Koninck, 1883.

### *raymondi* Hoare and Sturgeon, 1976, *Arcochiton*

*Arcochiton raymondi* Hoare and Sturgeon, 1976:842–843, pl. 1, fig. 1–20; pl. 2, fig. 4–12 [type species of *Arcochiton* Hoare and Sturgeon, 1976, by original designation]. Hoare and Sturgeon 1979:179–180, pl. 1, fig. 8–10; pl. 3, fig. 3. Hoare, Mapes, and Atwater 1983, fig 1B, 2F, 4E, F, 5P. DeBrock, Hoare, and Mapes 1984:1134, fig. 10A–M.

Geological Age.—Middle Pennsylvanian (Desmoinesian).

Localities.—USA: Ohio, Vanport Shale. Abandoned drift mine, S center sec. 24, T 8N, R 16W, Mulga Quadrangle, Milton Tp., Jackson Co.; also known from the Putnam Hill Shale and Lower Mercer Shale in Ohio.

Location of Material.—Holotype, OSU-30363; paratypes, OSU 30351–30362, 30364–30370; topotype, OSU-34824. Paratypes, BGSU-2744.

Remarks.—Valves small, short, and thin. Lateral and central areas not separated. Tail valve triangular in shape with a strongly concave keel, seen in lateral profile, which ends in a terminal mucro. Under surface (hypotyche) of the tail valve marked posteriorly by longitudinal ridges of coalesced granules and a central groove. Valve surfaces ornamented with small granules arranged in intersecting spiral lines. Reconstructed individual estimated to be 19.1 mm long and 5.1 mm wide.

Average dimensions are (mm):

| | Head | Intermediate | Tail |
|---|---|---|---|
| Length | 2.4 | 2.2 | 3.4 |
| Width | 5.9 | 5.2 | 3.1 |
| Height | 1.2 | 2.6 | 2.2 |

Van Belle (1978) placed *Arcochiton* in synonymy with *Acutichiton* Hoare, Sturgeon, and Hoare, 1972. We disagree with this assignment on the basis of *Arcochiton* having thinner valves, a strongly concave keel on the tail valve, and longitudinal ridges on the hypotyche of the tail valve.

### *riddlei* (Frederickson, 1962), *Glaphurochiton*?

*Helminthochiton* sp., Frederickson, 1956:65–66, fig. 1.
*Helminthochiton riddlei* Frederickson, 1962:298–302, fig. 1–3. Yochelson and Saunders 1967:12.
*Pterochiton riddlei* (Frederickson). Hoare, Sturgeon, and Hoare 1972:675.

Geological Age.—Upper Pennsylvanian (Missourian).

Locality.—USA: Oklahoma, Ada, in the lower part of the Francis Formation.

Location of Material.—Holotype reportedly in Oklahoma Geological Survey Collection, Norman, but unable to locate.

Remarks.—*Glaphurochiton riddlei* is based on a well-preserved specimen with six of the eight valves in place in the matrix. The two posterior valves are missing. The species appears to belong to the same general group as *Glaphurochiton carbonarius* (Stevens, 1858).

### *ryckholtianus* (Dall, 1882), *Pterochiton*

*Cymatochiton ryckholtianus* Dall, 1882:282. Nomen nudum.

Geological Age.—Lower Carboniferous.

Locality.—Belgium: Visé.

Location of Material.—Types in MCZ (fide Dall).

Remarks.—The pertinent material in the Schultze Collection in the MCZ has been studied. Originally, it was critically examined by P. P. Carpenter. The original label is as follows: "16376. *Chiton legiacus* de Ryckh. / Carb. / Visé." Also, there is a small accompanying label "Coll. Koninck." The lot consists of three spec-

imens, one a tiny fragment. Carpenter's note reads as follows: "16376. *Pterochiton legiacus,* de Ryckh., juv., = *gemmatus,* pars, de Kon., pl. 23, f. 2, c–d. (a) may be *gemmatus,* juv. (b) may be *Rhyckoltianus,* worn. Carb. Visé. These may not be conspecific."

Specimen (a), referred to by Carpenter, is a partial intermediate valve. The left sutural lamina seems to be present but is poorly defined. This, and the worn, beaded sculpture of the tegmentum argues for its identification as *Pterochiton subgemmatus* (d'Orbigny, 1850) [=*Chiton gemmatus* de Koninck (1844), preoccupied].

Specimen (b) is a little more than half of an intermediate valve showing the apex, jugal area, and the typical, rounded sutural lamina on the right side. The dorsal sculpture is not preserved. In all probability this also is *P. subgemmatus* but such an identification cannot be positive, as Carpenter intimated. The tiny fragment is too small for specific comment.

Because *Cymatochiton ryckholtianus* is a nomen nudum, introduced by Dall and not subsequently validated by any author, and because the material on which the name apparently is based is too poorly preserved and insufficient for positive identification, the specific name should be dropped and the specimens assigned to *Pterochiton.*

### *sagittalis* (Sandberger and Sandberger, 1856). Genus *incertae sedis*

*Chiton fasciatus* Sandberger, 1842:399. Nomen nudum. de Ryckholt 1845:62. Salter 1847:49. Bronn 1848:292. de Koninck 1857:192. Baily 1859:333; 1860:92 (and footnote). Rochebrune 1883:22–23.

*Chiton sagittalis* Sandberger and Sandberger 1856:239–240, pl. 26, fig. 23, 23a–b. de Koninck 1857:192 (footnote), 196. Baily 1859:333; 1860:92. Dall 1882:283. Rochebrune 1883: 22–23.

*Beloplaxus sagittalis* (Sandberger and Sandberger). Oehlert 1881:17 [type of *Beloplaxus* Oehlert, 1881, by original designation]. Fischer 1885:878–879. Etheridge 1897:68. Iredale and Hull 1926:326; 1927:141. Smith 1960:172.

Geological Age.—Middle Devonian (Stringocephalenkalk).

Locality.—Germany: Vilmar, in Hesse-Nassau.

Location of Material.—Unknown.

Remarks.—A review of Sandberger (1842) shows that *Chiton fasciatus* is a nomen nudum. De Koninck (1857) says that the Sandbergers changed the species name to *Chiton sagittalis* in 1856 without stating any reason why the older name was dropped. Oehlert (1881) makes *C. sagittalis* the genotype of his genus *Beloplaxus.*

Questions have been raised about the validity of *Beloplaxus sagittalis* as a polyplacophoran. Dall (1882) listed it with species "not found to be chitons or chitonoid." Rochebrune believed it to be a cirripede in the family Lepadidae or the septum of a *Cyrtina.* Fischer, as well as Iredale and Hull, expressed views that it was a doubtful polyplacophoran. On the other hand, Etheridge seemed to have little doubt of its polyplacophoran relationship, believing that the genera *Beloplaxus,* and *Sagmaplaxus* as well, should properly be identified as polyplacophorans.

The Schultze Collection in the MCZ contains a series of six fragments with the following label: "*Chiton sagittalis* Sandb. / Devonian / Vilmar." There is an accompanying note in P. P. Carpenter's handwriting, which reads as follows: "*Chiton sagittalis* Sandb., teste Schultze. Devonian. Vilmar. Dr. Dawson and I think they are Lepads." The fragments are fair-sized, showing a diagonally corrugated sculpture. It is obvious, as it was to Carpenter and Dawson, that they are not polyplacophorans but barnacle remains, perhaps referable to the genus *Turrilepas.*

The original figures in Sandberger and Sandberger (1856) are drawings, which show a side view of an intermediate valve, with top and bottom views of the same valve. It is extremely swept-wing or arrow-shaped in aspect with a length to width ratio of 3:2 and a height to width ratio of 3:1. The posterior sinus is V-shaped and has a depth of one-third the valve length. The ventral view shows a well-developed apical area, widest along the median line, becoming more narrow posteriorly and extending almost the full length of the valve on each side. There is no evidence of sutural laminae.

*Beloplaxus sagittalis* is rejected as a polyplacophoran for the purpose of this study.

### *sandbergianus* (de Ryckholt, 1845), *Pterochiton*

*Chiton priscus* Sandberger, 1842:399 [non] *C. priscus* Münster, 1839. de Koninck 1857:196. Baily 1859:333; 1860:95. Rochebrune 1883:21.

*Chiton sandbergianus* de Ryckholt, 1845:62 [new name for *C. priscus* Sandberger, 1842, preoccupied]. Bronn 1848:292. de Koninck 1857:196. Baily 1859:333; 1860:95. Rochebrune 1883:21.

*Pterochiton sandbergianus*? (de Ryckholt). Dall 1882:281.

GEOLOGICAL AGE.—Middle Devonian.
LOCALITY.—Germany: Vilmar, in Hesse-Nassau, 12.9 km SW of Weilberg, Prussia.
LOCATION OF MATERIAL.—MCZ (Schultze Collection).

REMARKS.—De Koninck considered *Chiton sandbergianus* to be the same as *C. corrugatus* Sandberger and Sandberger, 1853, *C. cordiformis* Sandberger, 1845, and *C. priscus* Sandberger, 1842. Dall placed it in the genus *Pterochiton* with a question as to its proper identification. Rochebrune placed both *C. priscus* and *C. sandbergianus* in the synonymy of *C. corrugatus*. Thus, there is considerable doubt about the validity of the species.

The Schultze Collection in the MCZ contains a single specimen accompanied by a note in P. P. Carpenter's handwriting, as follows: "Sent as part of '*Chiton corrugatus*, Sandb.' teste Schultze. Devonian. Vilmar. Not conspecific. ?*Pterochiton* ?*Sandbergianus*, De Ryckh." This specimen, which is a small, incomplete one, appears to be a well-preserved intermediate valve measuring about 10 mm long, 8 mm wide, and 6.5 mm high. Externally the valve is steep-sided with a rather sharp jugal ridge and well-defined, raised lateral areas. Sutural laminae, if they were present in life, are not preserved.

### *sarthacensis* (Oehlert, 1881), *Chelodes*?

*Sagmaplaxus sarthacensis* Oehlert, 1881:15–17, pl. 2, fig. 3, 3a–b [type species of *Sagmaplaxus* Oehlert, 1881, by original designation]. Rochebrune 1883:5 (footnote), 23 (footnote). Fischer 1885:878. Etheridge 1897:68. Iredale and Hull 1926: 326; 1927:141.

GEOLOGICAL AGE.—Lower Devonian.
LOCALITY.—France: Sarthe.
LOCATION OF MATERIAL.—Unknown.

REMARKS.—Rochebrune thought this species might be a cirripede in the family Lepadidae. Iredale and Hull also expressed doubts that it was a polyplacophoran. Lindström, on the other hand, believed it to be a polyplacophoran equal or close to the genus *Chelodes*; he also expressed the view that the genera *Sagmaplaxus* and *Beloplaxus* were closely related. Etheridge stated that the two taxa were not congeneric, a view adopted in the Treatise on Invertebrate Paleontology (Smith 1960).

Original material of both genera needs to be studied further before a final judgement can be made on the most likely systematic position of *Chelodes*? *sarthacensis*.

### *scaldianus* de Ryckholt, 1845. Genus *incertae sedis*

*Chiton scaldianus* de Ryckholt, 1845:46–47, pl. 1, fig. 4–6. Salter 1847:50, 52. Bronn 1848:292. Kirkby 1862:237. de Koninck 1883:211. Rochebrune 1883:32. Jaekel 1900:13. ?*Cymatochiton scaldianus* (de Ryckholt). Dall 1882: 282.

GEOLOGICAL AGE.—Lower Carboniferous.
LOCALITY.—Belgium: Tournai, ". . . dans l'argile subordinée ou système anthraxifère supérieur de Tournay" (de Ryckholt).
LOCATION OF MATERIAL.—Unknown.

REMARKS.—This species is based on two specimens, one with a length of 17 mm. Dall (1882) thought it had crustacean features. Rochebrune (1883) believed it might be a brachiopod in the genus *Spirifer* or a crustacean near *Philipsia*.

Based on this evidence, *Chiton scaldianus* probably is not a polyplacophoran.

### *secundus* Horný *in* Špinar, 1965, *Helminthochiton*?

*Helminthochiton*? *secundus* Horný *in* Špinar, 1965:320, fig. VIII-9.

GEOLOGICAL AGE.—Lower Devonian (Koneprusy Limestone).
LOCALITY.—Czechoslovakia (locality unknown).
LOCATION OF MATERIAL.—In "Muzea v Praze" (fide Horný).

REMARKS.—The specimen in the Natural History Museum of Prague was labeled by the late Professor-Director Jaroslav Perner as "*Chiton*? *secundus* Barr. sp." and appears to be a manuscript name (fide R. Horný). The illustration in Špinar (1965, fig. VIII-9) shows characteristics of *Helminthochiton*, but the preservation leaves questions as to the exact generic determination.

### *sellaeformis* (Butts, 1926), *Chelodes*

*Priscochiton*? *sellaeformis* Butts, 1926:125, pl. 31, fig. 7. *Chelodes*? *sellaeformis* (Butts). Smith *in* Smith and Toomey 1964:14.

GEOLOGICAL AGE.—Middle Ordovician (Chickamauga Limestone).
LOCALITY.—USA: Alabama, Birmingham. From the Chickamauga Limestone, Black River horizon, Mountain Terrace.
LOCATION OF MATERIAL.—Holotype, USNM-71523.

REMARKS.—The U.S. National Museum lot consists of two specimens, the larger measuring: length, 10.9 mm; width, 9.0 mm; height, 6.9 mm; overhang of apex (mucro), ~4.2 mm. It is not certain whether the specimens are intermediate or tail valves. The species was described at the same time as *Chelodes*? *mirabilis* (Butts, 1926)

from the Lower Ordovician Odenville Limestone and the two appear closely related although the valves of *C.? sellaeformis* are smaller. For the present, at least, this species may be assigned to the genus *Chelodes.*

### *settlensis* Rochebrune, 1883, *Protalochiton*

*Chiton*? sp. Kirkby, 1862:236, fig. 7–8.
*Protalochiton settlensis* Rochebrune, 1883:31 [new name; type species of *Protalochiton* Rochebrune, 1883 by monotypy]. Smith 1960:173, figs. 45,3a–b (ex Kirkby).

Geological Age.—Lower Carboniferous (Lower Scar).
Locality.—England: near Settle, Yorkshire, in the Lower Scar Limestone.
Location of Material.—Unknown.

Remarks.—*Protalochiton settlensis* is based on a single, shield-shaped valve that is longer than wide. It has the shell areas of the family Lepidopleuridae but as the articulamentum of the described valves is evidently not preserved, the systematic position of the species must remain indeterminate pending the collection and study of more and better material from the type locality.

### *silurica* Bischoff, 1981, *Cobcrephora*

*Cobcrephora silurica* Bischoff, 1981:189–191, pl. 1, fig. 1–16; pl. 2, fig. 18–29; pl. 4, fig. 42–43; pl. 5, fig. 44–46; pl. 6, fig. 47–48; pl. 7, fig. 51–56; text-fig. 5–6 [type species of *Cobcrephora* Bischoff, 1981, by original designation].

Geological Age.—Upper Ordovician to Upper Silurian.
Localities.—Australia. Types from limestone lenses in the Panuara Group southeast Cobblers Creek, Cobblers Creek area, approximately 30 km southwest of Orange, New South Wales. Also from the Bridge Creek Limestone along Bridge Creek, approximately 25 km southwest of Orange; Quarry Creek Limestone (type section) on south bank of Quarry Creek about 21 km west of Orange; Boree Creek Formation and Borenore Limestone 1 km west of Borenore Caves, approximately 22 km west northwest of Orange; Kildrummie Formation along south bank of Campbells River, 11 km south of Rockley, New South Wales; and, Cuga Burga volcanics, 4.5 km southeast of Wellington, New South Wales.
Location of Material.—Holotype (SMF 34371) and figured paratypes (SMF 34372–34397) deposited in the Senckenberg Museum, Frankfurt am Main, Republic of West Germany.

Remarks.—Valves composed of alternating lamellae of organic and apatitic material. Tegmentum and hypostracum layers apparently present. Head valve rhomboidal, folded under at posterior apex. Intermediate valves sphenoidal to trapezoidal in shape, longer than wide, with two subparallel jugal ridges and sutural laminae present. Tail valve acutely triangular, longer than wide and arched longitudinally and laterally.

Ranges of valve measurements (as given by Bischoff) (mm):

| | Length | Width |
|---|---|---|
| Head | 0.80–3.10 | 0.63–3.00 |
| Intermediate | 0.36–5.95 | 0.17–2.70 |
| Tail | 0.44–5.65 | 0.27–1.40 |

Length of a reconstructed individual, containing seven valves (Bischoff, 1981, text-fig. 6) is given as 15.0–33.0 mm. The 7-valved reconstruction was based in part upon Bergenhayn's (1955) interpretation of *Septemchiton* which has been shown to be erroneous by Rolfe (1981).

The valve microstructure appears to be polyplacophoran in nature and the ratio of three valve types appears to be consistent with this interpretation. The phosphatic composition is radically different from previously described taxa. If correct, it helps to substantiate the notion that phosphatic skeletal structures are intermediate in evolutionary position between nonshelled and calcareous mollusks. The erection of a new genus, *Cobcrephora,* new family, Cobcrephoridae, and new order, Phosphataloricata by Bischoff was necessary to accommodate these forms in the classification of the Polyplacophora.

### cf. *silurica* Bischoff, 1981, *Cobcrephora*

*Cobcrephora* cf. *silurica* Bischoff, 1981:191–192, pl. 2, fig. 17, 30.

Geological Age.—Lower Silurian.
Localities.—Australia. Bridge Creek Limestone along Bridge Creek, about 25 km southwest of Orange, New South Wales. Limestone in Panuara Group, southeast Cobblers Creek, Cobblers Creek area, approximately 30 km southwest of Orange, New South Wales.
Location of Material.—Figured specimens (SMF 34398–34399) deposited in the Senckenberg Museum, Frankfurt am Main, Republic of West Germany.

Remarks.—Two valves, which are different in outline from those included in *Cobcrephora silurica* Bischoff, 1981, are included here. One is broader posteriorly than normal, the other broadly heart-shaped. Both apparently have the phosphatic composition of other taxa in *Cobcrephora.*

### *simplex* (Raymond, 1910), *Gryphochiton*

*Glaphurochiton simplex* Raymond, 1910:153–154, pl. 24, fig.

11–12; pl. 28, fig. 14. Raymond 1911:84, 96, pl. 3, fig. 11–12. Cossman and Pissaro 1912:217.

*Helminthochiton simplex* (Raymond). Smith 1960:152. Yochelson and Saunders 1967:12. Hoare, Sturgeon, and Hoare 1972:679, pl. 2, fig. 7–16. Hoare and Sturgeon 1976:841, pl. 2, fig. 19, 20. Hoare and Sturgeon 1979:179–180, pl. 1, fig. 4–7; pl. 3, fig. 1. DeBrock, Hoare, and Mapes, 1984:1129–1131, fig. 2K, L, 8A–S.

*Gryphochiton simplex* (Raymond). Sirenko and Starobogatov 1977:35.

GEOLOGICAL AGE.—Pennsylvanian.

LOCALITY.—USA: Pennsylvania, from the Vanport Limestone, Allegheny Group. From old quarries of Green, Marquis, and Johnson, between New Castle and New Castle Junction (Raymond). Ohio, Lower Allegheny, in the Putnam Hill Limestone and the Vanport Shale (Hoare, Sturgeon, and Hoare). Texas, from the Lazy Bend Formation (DeBrock, Hoare, and Mapes).

LOCATION OF MATERIAL.—Holotype, CM 111 and paratype, CM 112 in the Carnegie Museum, Pittsburgh. Hypotypes OSU-27134–27142, 36046–36064 and BGSU-4227.

REMARKS.—Raymond (1911) reported *Gryphochiton simplex* from New Castle, Pennsylvania, old quarries of Green, Marquis, and Johnson, between New Castle and New Castle Junction, in the Vanport Limestone. Hoare, Sturgeon, and Hoare (1972) provided a recent description and excellent illustrations of the species. Their valve measurements are (mm):

| Head valve | | Intermediate valves | | Tail valves | |
|---|---|---|---|---|---|
| Length | Width | Length* | Width | Length* | Width |
| 3.5 | 6.5 | 5.5 | 5.5 | 10.0 | 7.5 |
| | | 7.0 | 8.0 | 6.6 | 6.6 |
| | | 4.5 | 7.0 | 7.2 | 7.0 |
| | | | | 7.5 | 6.8 |

* Not including the length of sutural laminae.

Numerous specimens from the Lazy Bend Formation in Texas are closely similar to those in Ohio and Pennsylvania (DeBrock, Hoare, and Mapes 1984).

## *solenoides* Young and Young *in* Young, 1868, *Solenocaris*

*Solenocaris solenoides* Young and Young *in* Young, 1868:171–173, pl. 1, fig. 7a, b. Rolfe 1981:677, text-fig. 3.

*Helminthochiton grayiae* Woodward, 1885. Reed 1907:113–114, pl. 4, fig. 8.

GEOLOGICAL AGE.—Upper Ordovician (Caradoc).

LOCALITY.—Scotland: Balclatchie Group, Penwhapple Glen, near Girvan, Ayrshire (Rolfe).

LOCATION OF MATERIAL.—Location of original specimen unknown. That figured by Reed (1907) and Rolfe (1981) in BM (N.H.) 20268a.

REMARKS.—This species was originally thought to be a crustacean by Young and Young *in* Young (1868). Reed (1907) agreed with Woodward (1885) that forms of this type belonged to the genus *Helminthochiton* Salter *in* McCoy, 1846. Subsequent restudy by Rolfe (1981) showed the presence of eight valves and the relationship to *Solenocaris* Young and Young *in* Young, 1868. Rolfe noted the presence of a greatly elongated tail valve as distinguishing *Solenocaris* from *Septemchiton* Bergenhayn, 1955. Rolfe *in* Morris (1967) had previously placed *Septemchiton* Bergenhayn, 1955 in synonomy with *Solenocaris*.

## *sluseanus* (de Ryckholt, 1845)

*Chiton sluseanus* de Ryckholt, 1845:55, 62. Bronn 1848:292 (as "sluceanus").

*Helminthochiton? sluseanus* (de Ryckholt). Salter 1847:52. Kirkby 1862:237 (as "*sluceanus*"). Bigsby 1878:319 (as "*sluzeanus*").

?*Pterochiton sluseanus* (de Ryckholt). Dall 1882:281.

*Anthracochiton sluseanus* (de Ryckholt). Rochebrune 1883:29.

*Rhombichiton sluseanus* (de Ryckholt). de Koninck 1883:206–207.

See: *subgemmatus* d'Orbigny, 1850.

GEOLOGICAL AGE.—Lower Carboniferous.

LOCALITY.—Belgium: Visé.

LOCATION OF MATERIAL.—MCZ (Schultze Collection). Probably also in PSM.

REMARKS.—De Ryckholt's illustrations show a granulated intermediate valve with a marked overhang at the apex and rather large, rounded sutural laminae, not markedly different from de Koninck's figures of his *Chiton gemmatus* [=*C. subgemmatus* d'Orbigny, 1850]. Dall (1882) said de Ryckholt's plate 4, figures 7–8 are actually *Chiton eburonicus* and that de Koninck failed to recognize this in his 1857 review. De Koninck (1883) thought *R. sluseanus* to be conspecific with *R. gemmatus* [=*subgemmatus*].

The Schultze Collection in the MCZ contains several lots of valves involving this species name. In P. P. Carpenter's notes on them it is plain he thought they should be identified as *Chiton gemmatus,* or at least a variety of *gemmatus*.

From the above, until further evidence to the contrary turns up, it would appear best to place *Chiton sluseanus* in the synonymy of *Pterochiton subgemmatus* (d'Orbigny, 1850).

## *soleaformis* (Etheridge, 1882), *Soleachiton*

*Chiton soleaformis* Etheridge, 1882:92–93, pl. 1, fig. 18–19.

*Soleachiton soleaformis* (Etheridge). Hoare and Smith 1984: 90.

GEOLOGICAL AGE.—Lower Carboniferous (Main or Hurlet Limestone).

LOCALITY.—Scotland: Law Quarry, near Dalry, Ayrshire.

LOCATION OF MATERIAL.—Collection of J. Bennie (fide Etheridge). Present location unknown.

REMARKS.—Because of the peculiar aspect of this species, Etheridge's description follows:

> Acutely triangular, slipper-like, elongate, prolonged backwards into a fine drawn-out point, sharply carinate in the median line, arched. Front margin excavated, arched; apophyses very delicate, simply projecting forwards, not continued laterally along the anterior margin. Surface microscopically granulated in transverse lines; no separation into areas by diagonal lines. On the lower surface there is an elongately triangular, flattened, incurved area, extending from the pointed posterior extremity, somewhat less than half the length of the plate, and with an unornamented surface. Interior, shoe-like.

The name is derived from *solea,* a sandal or slipper, spelled *solaeformis* incorrectly by Etheridge (1882:93 and in the plate explanation, p. 105). Although no dimensions of the valve are given, if the scale of Etheridge's illustrations is correct the valves are quite small, with a length of 2.75 mm and a maximum width of about 1.7 mm. On the ventral side the posterior pocket and the narrow sutural laminae are departures from the usual configuration of polyplacophoran valves, approximated somewhat by species in the genus *Chelodes* and in the genus *Priscochiton* for head valves only. Neither Etheridge nor Kirkby, with whom the former discussed these fossils, had any doubts about their polyplacophoran relationship.

### *spatulatus* (Hoare, Sturgeon, and Hoare, 1972), *Euleptochiton*

*Pterochiton spatulatus* Hoare, Sturgeon, and Hoare, 1972:678–679, pl. 3, fig. 1–14 [type species of *Euleptochiton* Smith and Hoare, designated herein]. Hoare and Sturgeon 1979:179–180, pl. 1, fig. 11–15; pl. 3, fig. 4. DeBrock, Hoare, and Mapes 1984:1129, fig. 2I, J, 7A–Y.

GEOLOGICAL AGE.—Middle Pennsylvanian (Desmoinesian).

LOCALITY.—USA: Ohio. Vanport Shale. Abandoned drift mine, S center sec. 24, T 8N, R 16W, Mulga Quadrangle, Milton Tp., Jackson Co., Texas, in the Lazy Bend Formation. Small tributary of Kickapoo Creek, 30 m north of crossing of Farm to Market Road 1189 and Rocky Branch, approximately 8.5 km NE of Lipan and 0.75 km south of Kickapoo Falls, Hood Co. Dennis 7½-minute Quadrangle.

LOCATION OF MATERIAL.—Holotype, OSU-27144; paratypes, OSU-27145–27157, and other specimens OSU-36002–36045. Paratypes, BGSU-2743 and other specimens, BGSU-4226.

REMARKS.—This species, from the type locality, where it is stated to be abundant, has the following measurements (mm):

| | Head | | Intermediate | | Tail | |
|---|---|---|---|---|---|---|
| | Length | Width | Length | Width | Length | Width |
| Largest | 2.5 | 4.8 | 4.4 | 6.5 | 3.2 | 4.9 |
| Smallest | 1.5 | 2.6 | 2.2 | 4.1 | 1.1 | 1.8 |

It is a relatively small species, differing from *Glaphurochiton carbonarius* (Stevens, 1858) in the following characters: the subtrapezoidal outline of the tail valve, the short keel and elevated mucro of the tail valve, and the short length of the intermediate valves. Specimens from the Lazy Bend Formation in Texas are slightly larger and thicker valved than those from the Vanport of Ohio (DeBrock, Hoare, and Mapes, 1984).

*Euleptochiton spatulatus* lacks the excavated anterolateral areas of *Pterochiton.* It, and a similar species, *E. tholus,* Hoare, Mapes, and Atwater (1983), and an undescribed species from the Virgilian of Texas have much finer ornamentation than that found in *Glaphurochiton* Raymond, 1910 and *Proleptochiton* Sirenko and Starobogatov, 1977. A new generic designation, *Euleptochiton,* was proposed for these taxa by Hoare and Mapes (1985:875) with *P. spatulatus* as type species. The genus is distinguished by having high arched valves, fine granulated ornamentation, broad and protruding sutural laminae, and a subtrapezoidal tail valve with the elevated mucro at the end of a short jugal ridge.

### *spinus* Yü, 1984, *Luyanhaochiton*

*Luyanhaochiton spinus* Yü, 1984:25, pl. 1, fig. 8, 9.

GEOLOGICAL AGE.—Lower Cambrian (Meishucun).

LOCALITY.—China: Zhongyicun Member, Dengying Formation in eastern Yunnan Province.

LOCATION OF MATERIAL.—Holotype 84135, Nanjing Institute of Geology and Palaeontology, Academia Sinica.

REMARKS.—This species is described by Yü (1984) as follows: "Shell minute-sized, elliptical and high-arched. Head valve semicircular. Intermediate valves wider than long. Tegmentum appearing to be weak developed areas, with an empty spine in the middle part. Ornamentations not well preserved, except for the micro-granules."

This silicified holotype, consisting of a head and two intermediate valves, is 0.88 mm long and 0.52 mm wide. Yü assigned the genus to a new family Yangtzechitonidae. The spinose character of the intermediate valves is diagnostic. No evidence of sutural laminae or insertion plates present.

*squarrosus,* DeBrock, Hoare, and Mapes, 1984, *Camptochiton*

*Camptochiton squarrosus* DeBrock, Hoare, and Mapes, 1984: 1120–1123, fig. 2A, B, 3A–U [type species of *Camptochiton* DeBrock, Hoare, and Mapes, 1984, by original designation].

Geological Age.—Middle Pennsylvanian (Desmoinesian).

Locality.—USA: Texas, Lazy Bend Formation exposed on a small tributary to Kickapoo Creek, 30 m N of where Farm to Market Road 1189 crosses Rocky Branch, approximately 8.5 km NE of Lipan and 0.75 km S of Kickapoo Falls, Hood Co. Dennis 7½-minute Quadrangle.

Location of Material.—Holotype, OSU-35957; paratypes, OSU-35958–35973 and BGSU-4223.

Remarks.—A reconstructed specimen is about 30 mm long with a length to width ratio of 2:1. The head valves are high and steep-sided, with a mucronate apex and a large apical area. The intermediate valves are swept-winged (apical angle averages 131°), twice as wide as long, a sharp jugum, slightly concave side-slopes, a large apical area, and short, broad sutural laminae that extend around the anterolateral corner as unslit insertion plates. The tail valves are suboval in shape with a steeply concave posterior slope below the mucro, which is located posterior to midlength; the short and broad sutural laminae extend well onto the lateral margins as unslit insertion plates. The valve surfaces are ornamented with coarse granules arranged in radiating rows from apex or mucro.

Average valve dimensions are (mm):

| | Head | Intermediate | Tail |
|---|---|---|---|
| Length | 3.6 | 3.5 | 3.2 |
| Width | 7.7 | 7.0 | 6.1 |
| Height | 2.5 | 2.5 | 1.6 |

The new genus *Camptochiton* was erected to include taxa which are intermediate between forms lacking insertion plates and those with slitted insertion plates. The extension of the sutural laminae onto the lateral valve margins appears to be a prelude to the development of separate slitted insertion plates.

*subantiquus* Kirkby and Young, 1867. Genus *incertae sedis*

*Chitonellus*? *subantiquus* Kirkby and Young, 1867:341, pl. 16, fig. 12a–b, 13. Etheridge 1882:98–99.

Geological Age.—Lower Carboniferous (Lower Scar).

Locality.—England: Settle, Yorkshire, at base of Lower Scar, Mountain Limestone.

Location of Material.—Unknown.

Remarks.—The species is based on two patelliform plates approaching the configuration of *Chitonellus antiquus* (Howse, 1848) from the Permian. The description of a nearly perfect, supposed intermediate valve is as follows:

> Conical, sub-pentagonal in marginal outline, apex recurved and placed rather behind the centre of the plate. Several fine ribs radiate from the apex down each side, and others appear to have originally existed in front and behind, but are not now visible on this specimen, owing to the imperfect preservation of the shell in these parts. Surface marked with strong lines of growth; length rather under three-eighths of an inch [9.5 mm]; breadth rather over two-eighths of an inch [6.5 mm].

Etheridge (1882) believed his *Chitonellus*? *patelliformis* was clearly allied with *C.*? *subantiquus* "but is distinguished by the lateral position of the radiating ridges in the latter, and other minor characters." It seems clear that both *C. patelliformis* and *C. subantiquus* should be rejected as polyplacophorans until compelling reasons for changing this status are developed.

*subgemmatus* (d'Orbigny, 1850), *Pterochiton*

*Chiton gemmatus* de Koninck, 1844:323, pl. 23, fig. 2a–e [non] *C. gemmatus* de Blainville, 1825. de Ryckholt 1845:59–60, pl. 4, fig. 1–4. Bronn 1848:292. d'Orbigny 1850:127. de Koninck 1857:195. Baily 1859:333; 1860:95. Kirkby 1862: 237. Bigsby 1878:319. Etheridge 1897:69. Dunlop 1915:168–169, pl. 22, fig. 4. Dunlop 1922:75. Bergenhayn 1945:389.

*Chiton sluseanus* de Ryckholt, 1845:55, 62. Bronn 1848:292 (as "*sluceanus*").

*Helminthochiton gemmatus* (de Koninck). Salter 1847:52.

*Helminthochiton*? *sluseanus* (de Ryckholt). Salter 1847:52. Kirkby 1862:237 (as "*sluceanus*"). Bigsby 1878:319 (as "*sluzeanus*").

*Pterochiton gemmatus* (de Koninck). Dall 1882:281. Pompeckj 1912:355, fig. 2a, b. Fischer 1957:12–13. Sirenko and Starobogatov 1977:36.

?*Pterochiton sluseanus* (de Ryckholt). Dall 1882:281.

*Anthracochiton gemmatus* (de Koninck). Rochebrune 1883: 27–28, pl. 3, fig. 13.

*Anthracochiton sluseanus* (de Ryckholt). Rochebrune 1883:29.

*Rhombichiton gemmatus* (de Koninck). de Koninck 1883:206, pl. 51, fig. 3–10, 28–31; pl. 52, fig. 1–17, 22–29.

*Rhombichiton sluseanus* (de Ryckholt). de Koninck 1883:206–207.

*Chiton subgemmatus* d'Orbigny, 1850:127 (new name for *C. gemmatus* de Koninck, 1844; [non] *C. gemmatus* de Blainville, 1825, a Recent species].

*Rhombichiton subgemmatus* (d'Orbigny). de Koninck 1883: 207. [non] *Helminthochiton* aff. *gemmatus* (de Koninck). Schmidt 1951:189, 190, pl. 13, fig. 11.

GEOLOGICAL AGE.—Lower Carboniferous.

LOCALITIES.—Belgium: Visé. England, Settle, Yorkshire. Scotland: Woodmill, Fife, Strathaven-on-Avon.

LOCATION OF MATERIAL.—PSM (de Koninck Collection) (fide P.-H. Fischer). Specimens under the name *Rhombichiton gemmatus* (de Koninck, 1842) from Belgium and from Fife, Scotland, in BM (N.H.) (fide H. W. Ball). MCZ (Schultze Collection). Specimens from Woodmill, Scotland in USNM.

REMARKS.—*Chiton gemmatus* was stated by de Koninck to be a fine, large species extremely rare in the Carboniferous limestone of Visé, Belgium, which is the type locality. The above synonymy is complicated by the fact that de Koninck's name was preoccupied, a situation recognized by d'Orbigny in 1850; d'Orbigny's rectification of the name was not accepted by de Koninck and was overlooked by subsequent authors, several of whom complicated the situation further in their taxonomic treatments.

De Koninck (1857) considered four of de Ryckholt's species described in 1845—*Chiton mosensis, C. viseticola, C. legiacus,* and *C. eburonicus*—to be conspecific with his *C. gemmatus,* bracketing them under a single number in his list of fossil species. Baily (1859) did the same in his translation of de Koninck's paper. In 1883, however, de Koninck listed *Rhombichiton subgemmatus* as a synonym of *R. gemmatus,* the reverse being correct, and in addition, he then included *R. mosensis*; *R. eburonicus*; *R. slusianus* [sic], all of de Ryckholt (1845); *R. sluceanus* Bronn, 1848; and *Chiton*? sp. nov. Kirkby, 1862 as synonyms. Dall (1882) referred to "*gemmatus* (Koninck) Ryckholt, 1845 . . . p. 59, no. 13, pl. 4, figs. 1, 2, 3, (fig. 4 forsitans exclus)." Rochebrune (1883) made "*gemmatus* Kon., 1842-44" and "*gemmatus* (part) Ryckh., 1845" synonyms of *Chiton subgemmatus.*

In discussing this species most authors base their identifications on specimens from Visé, Belgium. Dunlop (1915) discussed and illustrated what appears to be a cast of the ventral side of a polyplacophoran valve from Woodmill, Fife, in southern Scotland, found at Gallowhill, near Strathaven, which he identified as "*Chiton gemmatus.*" This specimen, he said, was lost in a fire, which is just as well, since the inside casts of polyplacophoran valves are practically useless in identification. Dunlop said *C. gemmatus* occurs near Woodmill "large and in good preservation and is the most plentiful." He pointed out that Etheridge (1882:91) showed the Strathaven specimen to be doubtfully identified as *C. gemmatus* on account of differences in valve shape and other characters. Dunlop's specimens were compared with de Koninck's figures of *C. gemmatus* by Dr. Wheelton Hind, who pronounced them as being identical. Later, in 1922, Dunlop considered *C. gemmatus, C. armstrongianus,* and *C. cordatus* to be conspecific, based on valves collected near Woodmill. Two small, imperfect intermediate valves from Woodmill, Dumfermline, Scotland, are in the collection of the USNM.

The identity of fossil polyplacophoran valves from England and southern Scotland with those of the true *C. subgemmatus* of Belgium does not appear to rest on sound ground. Comparison of them with actual type material in the PSM, rather than illustrations of them, would seem necessary.

The large and heavy sutural laminae and the general shape of the intermediate valves suggest that this species should be assigned to *Pterochiton* Carpenter *in* Dall, 1882 as broadly defined.

### *subgranosus* Sandberger, 1842

*Chiton subgranosus* Sandberger, 1842:399. Nomen nudum. See: *corrugatus* Sandberger and Sandberger, 1856.

### *subquadratus* (Kirkby and Young, 1867), *Glyptochiton*

*Chitonellus subquadratus* Kirkby and Young, 1867:342, pl. 16, fig. 5. Etheridge 1882:96–97, pl. 2, fig. 4–5. Young 1878: 324.

*Glyptochiton subquadratus* (Kirkby and Young). Smith 1971: 567, 572. Sirenko and Starobogatov 1977: 37.

GEOLOGICAL AGE.—Carboniferous.

LOCALITY.—Western Scotland: Lower and Upper Limestone, Craigenglen, Campsie, Ayrshire (Kirkby and Young); Law Quarry, near Dalry, Ayrshire (Etheridge).

LOCATION OF MATERIAL.—Collection of J. Bennie (fide Etheridge). Present location unknown.

REMARKS.—The species is based on a single, supposed intermediate valve, with the anterior margins ridged and forked, terminating in pointed projections. The illustration shows sinuses at each end of the valve. The exposed valve area is heart-shaped, occupies about one-fifth of the total valve area, is slightly elevated, and granulated around the margin. Numerous delicate striae

fringe the heart-shaped area on the dorsal valve surface, which presumably is buried in the mantle of the animal in life. Dimensions are: length, ¼ inch (6.4 mm); breadth, ⅛ inch (3.2 mm). Etheridge reported another, similar valve from a slightly different locality, which he illustrated.

*Chitonellus subquadratus* is a unique type of polyplacophoran in the Paleozoic related to *Glyptochiton cordifer* (de Koninck, 1844) from the Carboniferous of Belgium. Also related, perhaps even more closely, are the Scottish Carboniferous species *G. youngianus* (Kirkby *in* Young, 1865), *G. kirkbyanus* (Etheridge, 1882), and *G. quadratus* (Etheridge, 1882).

### *symmetricus* Trenkner, 1868

*Chiton symmetricus* Trenkner, 1868:137, pl. 2, fig. 30. Clarke 1885:338.
See: *corrugatus* Sandberger and Sandberger, 1856.

Geological Age.—Devonian.
Locality.—Germany: Winterborg, Hartz Mts.
Location of Material.—Unknown.

Remarks.—Clarke (1885) considers this species to be identical with *Probolaeum corrugatus* (Sandberger and Sandberger, 1856), and we agree.

### *texanus* Girty, 1909, *Cymatochiton*?

*Cymatochiton*? *texanus* Girty, 1909:451, pl. 29, fig. 21, 21a. Branson 1948:761.
*Cymatochiton*? *texanus* Girty. Yochelson 1971:130, 132.
*Pterochiton*? *texanus* (Girty). Hoare and Smith 1984:82, fig. 10N–P.

Geological Age.—Permian.
Locality.—USA: Texas, Delaware Mountain Formation, South Delaware Mts., 48.3 km east of Van Horn, Van Horn Quadrangle. U.S. Geological Survey locality G-2969-PC.
Location of Material.—Holotype, USNM-118324.

Remarks.—The species is based on a single, poorly preserved, intermediate valve collected by G. B. Richardson. It is triangular, rather low-arched, with a blunt jugal ridge and gently convex side-slopes that form an angle of divergence of slightly more than 90°. The posterior margins sweep forward and form an angle of a little less than 90° at the weakly mucronate apex. There is no evidence of insertion plates. The sutural laminae are well developed, subtriangular in shape, with a rather narrow sinus between them. On the ventral side the articulamentum has two thickened ridges extending from the bases of the sutural laminae nearly to the valve apex. All traces of dorsal sculpture, if any, have been lost in preservation, the valve showing a coarse crystalline structure resulting from acid etching. Measurements are: length (over-all), 6.6 mm; length along the dorsal median line, apex to base of sutural sinus, 5.5 mm; height, 2.5 mm.

Assignment of this valve to *Cymatochiton* Dall, 1882 [type *C. loftusianus* King, 1848, by original designation] from the Permian of England can be based only on the triangular shape of the intermediate valve of *C. texanus* as compared with that of *C. loftusianus*. *Cymatochiton texanus* does not seem to be related in any way to other beautifully preserved, acid-etched valves from the Permian of West Texas in the collection of the USNM. Thus its systematic position must remain tentative pending collection and study of additional material from the type locality, especially head and tail valves.

The above comments are based on a study of the unique holotype of *Cymatochiton texanus* [loaned through the courtesy of Dr. Jess Merida of the United States Geological Survey, Washington, D.C.].

### *tholus* (Hoare, Mapes, and Atwater, 1983), *Euleptochiton*

*Pterochiton tholus* Hoare, Mapes, and Atwater, 1983:997–999, fig. 2C, 5A–K.

Geological Age.—Lower Pennsylvanian (Morrowan).
Locality.—USA: Oklahoma, Gene Autry Formation exposed in gullies on east side of unnamed tributary of Sycamore Creek on the Daube Ranch, NW¼ NW¼ SW¼, sec. 2, T 4S, R 4E, Johnson Co.
Location of Material.—Holotype, OSU-34809; paratypes, OSU-34810–34817.

Remarks.—A very small species approximately 10 mm long and 3.5 mm wide when reconstructed giving a length to width ratio of 2.9:1. The valves are ornamented by very fine pustules in a quincunx pattern. The lateral margins of the intermediate valves are narrowly rounded and the tail valve is highly arched with steep slopes. The mucro on the tail valve is located further posteriorly than in *Euleptochiton spatulatus* (Hoare, Sturgeon, and Hoare, 1972).

Average dimensions are (mm):

| | Head | Intermediate | Tail |
|---|---|---|---|
| Length | 1.3 | 1.8 | 2.0 |
| Width | 2.7 | 3.3 | 2.6 |
| Height | 1.2 | 1.4 | 1.3 |

*thomondiensis* (Baily, 1859), *Pterochiton*

*Chiton thomondiensis* Baily, 1859:331–332, pl. 28, fig. 2, 2a–c. Baily 1860:95 (and footnote). Kirkby 1862:237. Rochebrune 1883:4.
*Pterochiton thomondiensis* (Baily). Dall 1882:281. Sirenko and Starobogatov 1977:36.
*Anthracochiton thomondiensis* (Baily). Rochebrune 1883:27.

GEOLOGICAL AGE.—Carboniferous.
LOCALITY.—Ireland: Carboniferous limestone of Lisbane and Rathkeale, County Limerick.
LOCATION OF MATERIAL.—Specimens in BM (N.H.) (fide H. W. Ball).

REMARKS.— *Chiton thomondiensis* is based on four detached intermediate valves with two fragments "of what appears to be the under surface of its very thin shell, showing markings for the attachment of muscles . . . ." Two of the valves are beautifully preserved. Baily's measurements (converted from inches to mm) are:

| | Width | Length | Height |
|---|---|---|---|
| Largest | 33.0 | 22.9 | 3.2 |
| Medium | 30.2 | 13.5 | – |
| Smallest | 22.9 | 17.8 | – |

The enlarged reconstruction of an entire animal (valves only) is upside down on the plate (fig. 2c). Baily's description follows:

> Shell elongated. Plates subquadrate and very thick, broader than long, having a median elevation, or prominent ridge, with an acuminated apex; surface concentrically striated by lines of growth, which become broken into granulations on each side of the central ridge, about ten faint radiating lines proceeding from the apex to the posterior margin; apophyses widely separated.

Baily's paper describing this species was read at a meeting of the Geological Society of Dublin in June 1859. Since his first collection of "plates belonging to several individuals" he found more later "in a cutting at Rathkeale, on the Limerick and Foynes Railway." He thought his species was related to *Chiton gemmatus* de Koninck, 1844 [=*C. subgemmatus* d'Orbigny, 1850] and that it might occupy a position between this and *Helminthochiton priscus* (Münster, 1839).

*Chiton thomondiensis* is the first in the list of Rochebrune's species assigned to *Anthracochiton* Rochebrune, 1833 and is herein selected as the type species of that genus. The broad, well-developed sutural laminae and excavated anterolateral margins of this species are evidence for its allocation to the genus *Pterochiton* Carpenter *in* Dall, 1882 of which *Anthracochiton* is considered to be a synonym.

*thraivensis* (Reed, 1911), *Septemchiton*?

*Helminthochiton thraivensis* Reed, 1911:337–339, pl. 15, Smith 1960:148, fig. 33,2a–c.
*Gotlandochiton thraivensis* (Reed). Sirenko and Starobogatov 1977:31.
*Septemchiton*? *thraivensis* Rolfe, 1981:677.

GEOLOGICAL AGE.—Middle Ordovician (Upper Bala).
LOCALITY.—Scotland: Thraive Glen, Girvan, from the Starfish Beds (Upper Bala).
LOCATION OF MATERIAL.—Holotype, along with other examples, in BM (N.H.) (fide H. W. Ball).

REMARKS.—Reed's illustrations are good; one showing a complete specimen with girdle spicules is well preserved. According to Reed, other specimens show valve pores in both cast and mold; he says there are several more or less perfect specimens in Gray's collection.

The single specimen with preserved girdle spicules is only one of two species that throws any light whatever on the girdle characters of Paleozoic polyplacophorans, the other being *Glaphurochiton concinnus* (Richardson, 1956). It would be assuming too much to infer that the typical Paleozoic polyplacophoran had a spiculose girdle although such an assumption might be a reasonable one in view of the fact that many Recent species in the family Lepidopleuridae have a spiculose girdle decoration.

*tornacicola* de Ryckholt, 1845.
Genus *incertae sedis*

*Chiton tornacicola* de Ryckholt, 1845:45–46, pl. 1, fig. 1–3. Salter 1847:50, 52. Bronn 1848:292. Kirkby 1862:237. de Koninck 1883:211. Rochebrune 1883:32. Jaekel 1900:13.
?*Cymatochiton tornaticola* [sic] Dall, 1882:282.

GEOLOGICAL AGE.—Lower Carboniferous.
LOCALITY.—Belgium: Tournai, ". . . dans l'argile de Tournay, subordinée au système anthraxifère supérieur . . ." (de Ryckholt).
LOCATION OF MATERIAL.—Unknown.

REMARKS.—This species is based on two extremely small specimens, 4 mm in length. De Koninck (1883), thought one represented a species of cephalopod. Dall (1882) thought it had "some crustacean features" and Rochebrune referred it to the crustacean *Philipsia*.

The identification of *Chiton tornacicola* as a polyplacophoran is here rejected.

*torus* Hoare and Mapes, 1985*a*, *Euleptochiton*

*Euleptochiton torus* Hoare and Mapes, 1985*a*:875–877, fig. 1.

Geological Age.—Upper Pennsylvanian (Virgilian).

Locality.—USA: Texas, Finis Shale exposed in gullies south of dam, 0.4 km east of Hwy. 59 and 8.3 km NE of Jacksboro, Jack Co., Cundiff 7½-minute Quadrangle.

Location of Material.—Holotype, OSU-36982; paratypes, OSU-36983–36991; BGSU-4446.

Remarks.—Reconstructed specimens are small, about 20 mm long, and have broad sutural laminae. The intermediate and tail valves show slight divisions into lateral, central, and posterior areas. The intermediate valves bear a distinct narrow jugal ridge that projects as a jugum into the jugal sinus. The tail valves are semicircular with the mucro located anterior to midlength. The head valve is unknown.

Average dimensions are (mm):

| | Intermediate | Tail |
|---|---|---|
| Length | 4.0 | 3.0 |
| Width | 6.5 | 4.9 |
| Height | 2.8 | 1.6 |

This genus and species was mistakenly assigned originally to the family Ochmazochitonidae Hoare and Smith, 1984 by Hoare and Mapes (1985*a*). It is here placed in the Permochitonidae Sirenko and Starobogatov, 1977.

*trapezoidalis* Trenkner, 1868, "*Chiton*"

*Chiton trapezoidalis* Trenkner, 1868:137–138, pl. 2, fig. 32. Clarke 1885:338–339. Quenstedt 1931:553.

Geological Age.—Upper Devonian (Ibergerkalk).

Locality.—Germany: Winterborg, Hartz Mts.

Location of Material.—Unknown.

Remarks.—The species is based on an intermediate valve 13 mm long and 23 mm wide. Clarke (1885) placed *Chiton* [=*Probolaeum*] *corrugatus* Sandberger and Sandberger, 1856 in synonymy with "*C.*" *trapezoidalis*, which is incorrect as the Sandberger species is the older.

*triangulatum* Carpenter *in* Dall, 1882, *Gryphochiton*

*Gryphochiton triangulatum* Carpenter *in* Dall, 1882:280.

Geological Age.—Lower Carboniferous.

Locality.—Belgium: Tournai.

Location of Material.—Specimens provisionally identified as this species by P. P. Carpenter, MCZ (Schultze Collection).

Remarks.—This species name is based on Carpenter's manuscript and, according to Dall, applies only to specimens illustrated by de Ryckholt (1845) in his plate 2, figures 4, 9–10. Actually, figure 4 is listed as *Chiton turnacianus*: figures 9–10 as *C. mempiscus*. Apparently he thought these illustrations represented a different species.

The Schultze Collection in the MCZ contains a specimen from Tournai (part of Lot No. 16370), with a note in Carpenter's handwriting as follows: "Probably part of side valve of *Gryphochiton triangulatus* (but may be another species, allied to *Rhyckholtianus*). If this is *triangulatus* a good deal has been lost behind." This specimen consists only of the left half of an intermediate valve with indications of a rather short sutural lamina. The upper surface is irregularly and deeply grooved concentrically, with a suggestion of some scattered, rounded granules. It seems to belong to the genus *Gryphochiton*, the species indeterminate. Another specimen (from Lot No. 16379) has the following Carpenter comment: "16379 *Chiton priscus* (pars) teste Koninck. Carb. Tournay =*Gryphochiton triangulatus*. (Probably part of post[erior valve] but may be centr. valve)." While too fragmentary to identify with any certainty, it has the swept-wing appearance on which Carpenter's name was based. (For a similar swept-wing chiton, see Smith (1960), p. I53, fig. 36,6b–d.)

*Gryphochiton triangulatum*, therefore must rest its identity on only the slim evidence of old illustrations. It can be validated only if de Ryckholt's actual specimens can be found and studied with reference to other named species from Belgium.

*troedssoni* Bergenhayn, 1955, *Gotlandochiton*

*Gotlandochiton troedssoni* Bergenhayn, 1955:19–20, pl. 1, fig. 9 (type); pl. 2, fig. 7 (reconstruction). Smith 1960:I50, fig. 34,7 (type) [ex Bergenhayn]. Van Belle 1975*a*, pl. 1, fig. 7. Sirenko and Starobogatov 1977:31.

Geological Age.—Silurian (Gotlandian).

Locality.—Sweden: Gotland. Landspitze von Grötlingbo and Gansviken, Grötlingbo.

Location of Material.—Type, RM Mo-6032; syntype? (or paratype), RM Mo-6036.

Remarks.—The species is based on half of an intermediate valve and two other intermediate valves. Bergenhayn's illustration of the type

specimen lacks detail and indicates a much-worn and possibly a poorly-preserved valve.

### *tumidus* de Koninck, 1857, "*Chiton*"

*Chiton* sp. Roemer, 1855:36, pl. 7, fig. 9a–b.
*Chiton tumidus* de Koninck, 1857:196 (new name). Baily 1859: 333; 1860:95. Rochebrune 1883:24.

Geological Age.—Upper Devonian.
Locality.—Germany: Grund, Hartz Mts.
Location of Material.—Unknown.

Remarks.—According to Rochebrune, de Koninck named this species from an undesignated illustration published by Roemer. He doubted that it was a polyplacophoran, believing it to be a brachiopod (*Spirifer*) or possibly a limpet (*Leptena*). Roemer's (1855) illustrations appear to represent a head valve of a polyplacophoran.

### *turnacianus* (de Ryckholt, 1845), *Gryphochiton*

*Chiton turnacianus* de Ryckholt, 1845:54–55, 62, pl. 2, fig. 1–4. Bronn 1848:292. de Koninck 1857:196. Baily 1859:333; 1860:95. Kirkby 1862:237. Bigsby 1878:318.
*Gryphochiton turnacianus* (de Ryckholt). Rochebrune 1883: 25, 26. Sirenko and Starobogatov 1977:35.
*Helminthochiton turnacianus* (de Ryckholt). Salter 1847:52. de Koninck 1883:201, pl. 50, fig. 32; pl. 51, fig. 1–2, 15–18, 23, 24.

Geological Age.—Lower Carboniferous.
Locality.—Belgium: Tournai. From "l'argile subordinée ou système anthraxifère supérieur de Tournay" (de Ryckholt).
Location of Material.—PSM (Rochebrune), but P.-H. Fischer does not list it from this collection. BM (N.H.) (fide H. W. Ball).

Remarks.—De Ryckholt illustrated an intermediate and a tail valve. The side view of the latter shows small sutural laminae but the view of the intermediate valve does not. In the Schultze Collection in the MCZ there are three large intermediate valves (Lot. No. 16370) from Tournai accompanied by the following note by P. P. Carpenter: "16,370 *Chiton priscus* (pars) DeKoninck Carb. Tournay. =*Gryphochiton mempiscus* DeRyckholt (=*turnacianus* DeKon. in Va. [=Vienna?] Mus." Rochebrune (1883) thought *Helminthochiton turnacianus* and *H. priscus* (Münster, 1839) were conspecific.

The validity of "*Chiton*" *turnacianus*, and "*C.*" *mempiscus* de Ryckholt, 1845, as well, both need more specific proof than is presently available that either or both are separable from *priscus*. The allocation to the genus *Gryphochiton* Gray (1847*a*) seems proper for these species.

### *variabilis* Walcott, 1885, *Matthevia*

*Matthevia variabilis* Walcott, 1885:17, pl. 20, fig. 1–6 [type species of *Matthevia* Walcott, 1885, by original designation]. Walcott 1886:223–225, pl. 32, fig. 1–12; pl. 33, fig. 1, 1a–f. Miller 1889:392, fig. 647. Lesley 1889:381–382 (text-fig. ex Walcott 1886). Walcott 1912:265, pl. 41. Fisher 1962:128, text-fig. 72, 1a–g. Yochelson 1966:B1–B11, text-fig. 1–2, 3A–C, pl. 1. Runnegar, Pojeta, Taylor, and Collins 1979:1390, pl. 1, fig. 5–30, text-fig. 1.

Geological Age.—Upper Cambrian, correlative of the lower part of the Trempealeau, the youngest of the three stages of the Upper Cambrian.
Localities.—USA: New York, near Saratoga Springs, Hoyt Limestone Member, Theresa Dolomite (Walcott). Texas, Wilberns Formation (Cloud and Barnes). Utah, Desert Valley, Ajax Formation (Reso). Nevada, Nopah Formation. Oklahoma, Arbuckle Mts. (Josiah Bridge, fide W. Ham). For details, see Yochelson, McAllister, and Reso. ?Alberta (Yochelson and Taylor). Wisconsin, near Baraboo, Black Earth Member, St. Lawrence Formation (Runnegar, Pojeta, Taylor, and Collins).
Location of Material.—Lectotype, USNM-146894; paralectotypes, USNM-258992–259002, plus other specimens.

Remarks.—Yochelson (1966) has proposed the establishment of a new class in the Mollusca, Mattheva, for *M. variabilis,* placing it in the family Matthevidae Walcott, 1885, genus *Matthevia.* He provides a thorough description and discussion along with excellent illustrations. The lanceolate shape of many of the *Matthevia* fossils is somewhat similar to that described as *Calceochiton hachitae* Flower, 1968, from the Early Ordovician of New Mexico, and also *Calceochiton* cf. *gibberosum* (Sardeson, 1896), neither of which, however, exhibit the ventral pocket in many of the valves of *Matthevia.* Polyplacophoran valves that do have a ventral pocket, from the Early Carboniferous of Scotland and the Permian of West Texas, are quite small in size and considered to be tail valves (intermediate valves are normal in shape with no ventral pocket); they are placed in a proposed new genus, *Soleachiton* (Hoare and Smith 1984:90).

Yochelson interpreted *Matthevia* fossils to consist of head and tail valves only. Thus he made no attempt to equate them with the Polyplacophora although he does not rule out the possibility that intermediate valves might exist. Smith studied these fossils with Yochelson several years ago and was in agreement with this view. He felt the attempt to pick out specimens that might be called intermediate valves was

tempting, but they were unable to do this with any assurance at that time.

Runnegar and Pojeta (1974), and later Runnegar et al. (1979), took the step of classifying *Matthevia* in the Polyplacophora, evidently basing this decision on a study of valves of a species of chelodid polyplacophoran from the Early Ordovician of Australia. Under this hypothesis, *Matthevia* from the Cambrian represents primitive stock from which an Early Ordovician chelodid developed (as represented by the Australian fossil), followed by a later development of the genus *Chelodes* in the Lower Paleozoic. Under this hypothesis, the evolutionary trend begins with rather pointed, lanceolate valves growing in an erect position in life and continues with a gradual flattening, widening, and possibly a thickening of the valves more or less similar to the supposed somewhat flattened but extensively overlapping valves of *Chelodes*. Also assumed is the fact that the 8-valved condition of the Polyplacophora may have been a primitive development.

### *variegatus* Bergenhayn, 1955, *Chelodes*

*Chelodes variegatus* Bergenhayn, 1955:13–14, pl. 1, fig. 4 (type); pl. 2, fig. 3 (reconstruction). Sirenko and Starobogatov 1977: 31.

Geological Age.—Silurian (Gotlandian).

Locality.—Sweden: Gotland, Grötlingbo, Gansviken, and Atlingbo.

Location of Material.—Type, RM Mo-6011; syntype? (or paratype), RM Mo-6005.

Remarks.—The species is based on two intermediate valves. Bergenhayn illustrated only the side view of his type specimen.

### *vermiformis* Bergenhayn, 1955

*Septemchiton vermiformis* Bergenhayn, 1955:24–26, pl. 1, fig. 15 (type); pl. 2, fig. 13 (reconstruction), 13a–b. Smith 1960: 150, fig. 35,1a–f (ex Bergenhayn). Rolfe 1981:675–678, text-fig. 1–3.

See: *grayiae* Woodward, 1885.

Geological Age.—Middle Ordovician (Upper Bala).

Locality.—South Scotland: from the Starfish bed.

Location of Material.—BM (N.H.) G-47222, a complete specimen with all valves in place in the matrix.

Remarks.—Bergenhayn's name is a subjective junior synonym of *Septemchiton grayiae* (Woodward, 1885).

### *viseticola* (de Ryckholt, 1845), *Gryphochiton*

*Chiton viseticola* de Ryckholt, 1845:51, 62, pl. 3, fig. 10–11. Bronn 1848:292. de Koninck 1857:195. Baily 1859:333; 1860: 95. Kirkby 1862:237. Bigsby 1878:319. Rochebrune 1883: 32.

*Gryphochiton* (*Chonechiton*) *viseticola* (de Ryckholt). Dall 1882: 281.

*Chonechiton viseticola* (de Ryckholt). Tryon 1883:339, pl. 85, fig. 59.

*Helminthochiton viseticola* (de Ryckholt). Salter 1847:52. de Koninck 1883:205, pl. 51, fig. 37–40; pl. 53, fig. 12–20.

*Gryphochiton viseticola* (de Ryckholt). Sirenko and Starobogatov 1977:35.

Geological Age.—Lower Carboniferous.

Locality.—Belgium: Visé, from the . . . "anthraxifère supérieur . . ." (de Ryckholt).

Location of Material.—MCZ (Schultze Collection).

Remarks.—This may be a valid polyplacophoran species although de Ryckholt's illustration of the single valve in matrix does not show any sutural laminae. In the Schultze Collection in the MCZ there are five specimens and several fragments with an original label carrying this species name. P. P. Carpenter's handwritten note accompanying the fragments indicated he agreed with the identification. Although preservation is poor for the most part, one of the larger valves and one smaller one have a microsculpture of extremely fine, closely-spaced granules seen only under a magnification of ×10 or higher. Another small valve represents a beaked polyplacophoran but is incomplete and has no particular distinguishing characters.

Both de Koninck and Baily consider that *Chiton viseticola* may be conspecific with *C. gemmatus* [=*C. subgemmatus* d'Orbigny, 1850] or a subspecies of it. Rochebrune said it was hard to believe it was a polyplacophoran at all. Dall, on the other hand, made *C. viseticola* the type of the subgenus *Chonechiton* Carpenter (1882) of the genus *Gryphochiton* Gray, 1847*a*. If Dall is correct, the species should be allocated to the genus *Gryphochiton*.

### *walcotti*, Runnegar, Pojeta, Taylor, and Collins, 1979, *Matthevia*

*Matthevia walcotti* Runnegar, Pojeta, Taylor, and Collins, 1979: 1390–1391, pl. 1, fig. 1–3.

Geological Age.—Upper Cambrian (Trempealeauan).

Localities.—USA: Black Earth Member, St. Lawrence Formation, Eikey quarry, 9 km east of Baraboo, Wisconsin (USGS locality 217, old series) and 2 km west of Black Earth, Wisconsin (USGS locality 418A, old series). Also at Reservoir Hill

(Bed 21), Mazomanie, Wisconsin (USGS locality 434X1, old series).

LOCATION OF MATERIAL.—Holotype, USNM-258989; figured paratype, USNM-258990.

REMARKS.—Described from four body valves which are tall, conical, and probably tapered to a sharp apex. The anterior and posterior margins are deeply embayed and have only one hole ventrally on the posterior side thus differing from *Matthevia variabilis* Walcott, 1885.

### *whitehousei* Runnegar, Pojeta, Taylor, and Collins, 1979, *Chelodes*

*Chelodes* sp. Runnegar and Pojeta, 1974:312, fig. 3M–O, 5 (middle drawing, reconstruction).

*Chelodes whitehousei* Runnegar, Pojeta, Taylor, and Collins, 1979:1388–1389, pl. 2, fig. 1–59. Stait and Burrett 1984: 112, fig. 1.

GEOLOGICAL AGE.—Lower Ordovician (lower Tremadocian).

LOCALITY.—Australia. Ninmaroo Formation, Mt. Datson, 50 km east-northeast of Boulia, Queensland; QM locality L 278/G25, Glenormiston Station road about 5 km east of No. 21 Bore; QM locality L 278/G24, Glenormiston Station road about 8 km east of No. 21 Bore.

LOCATION OF MATERIAL.—Holotype (UQ F30894) and figured paratypes (UQ F30769A–H, 30959, 30873, 30766), University of Queensland and figured paratypes (QM F10087–10104), Queensland Museum.

REMARKS.—Head valves unknown. Body valves are narrowly elongate with deep depressions ventrally and embayed anterior margins. The tail valves are rectangular to triangular in dorsal view, deeply concave ventrally with a small tapering hole beneath the apex, embayed anterior margin and apex located posteriorly. Runnegar and Pojeta (1974) said it is: "intermediate in form between *Chelodes* and the enigmatic Late Cambrian fossil *Matthevia* Walcott" which they believe to be a polyplacophoran.

Runnegar et al. (1979) believe that more than one species may be included here.

### *woodmillensis* Dunlop, 1915, "*Chiton*"

*Chiton woodmillensis* Dunlop, 1915:169, pl. 22, fig. 5.

GEOLOGICAL AGE.—Lower Carboniferous.

LOCALITY.—Scotland: Fife; about 1.6 km southeast of Dumfernline Lower Railway, on the Lyne Burn, and at the bend of the burn below Woodmill Beachfield in strata containing fossils that rest on the Hurlet Limestone.

LOCATION OF MATERIAL.—Specimens from Fife, Scotland, in BM (N.H.) (fide H. W. Ball).

REMARKS.—In discussing the fossil polyplacophorans found at Fife, Dunlop said: "I can find nothing figured to compare with Fig. 5: the specimen has a cornice around it that none of the others has, and I name it provisionally *Chiton woodmillensis.*" This meager description and the poor illustration of the specimen referred to combine to make any further identification impossible without careful study and comparison with other described species. Other species cited by Dunlop from the same area are *Chiton gemmatus* [=*C. subgemmatus* d'Orbigny, 1850], *C. armstrongianus,* and *C. cordatus.*

Later, in 1922, Dunlop discussed the fossil polyplacophorans of Woodmill further and raised the question whether they are not all one species. He said: "In the first place, they all seem to have been living in a little carboniferous pool about 10 or 12 feet broad, but of unknown length, as I have worked only about 2 feet. Out of this pool I have received over eighty specimens of *Gemmatus,* fourteen of *Armstrongianus* and twelve of *Cordatus.* These sometimes have been found together, and their relative numbers suggest that they represent but one species of Chiton. All three species also present the same microscopic structure . . . ."

### *wrightianus* de Koninck, 1857. Genus *incertae sedis*

*Chiton wrightianus* de Koninck, 1857:196, 199, pl. 1, fig. 2a–c. Baily 1859:333; 1860:96, 97, pl. 2, fig. 2a–c. de Koninck 1860:97, pl. 2, fig. 2a–c. Woodward 1865:489, pl. 14, fig. 1a–l. Dall 1882:283. Rochebrune 1883:20. Quenstedt 1882: 682. Withers 1926:37–42, pl. 5, fig. 1–6; pl. 6, fig. 1–8.

GEOLOGICAL AGE.—Silurian (Wenlock).

LOCALITY.—England: near Dudley.

LOCATION OF MATERIAL.—Holotype, BM (N.H.) I-16283 plus two additional specimens (fide Withers).

ORIGINAL DESCRIPTION.—"The form of the dorsal plates of this species is subtriangular, the posterior edges making very nearly a right angle. The lateral areas are rounded, and the anterior edge is very sinuous. All the plates are supplied with a well marked median carina, and appear to be without apophyses. The surface is covered with a small number of deep equidistant striae. The test is slender. The median area is larger than the lateral one.

Dimensions.—The length of each dorsal plate is about 8 millimeters, and the breadth 12 mm" (de Koninck 1857:199).

REMARKS.—De Koninck's illustrations are stylized drawings. Figure 2a shows a matrix with two adjacent valves having partial coverage. Figure 2b is an edge view of a valve from the posterior end. Figure 2c shows a reconstruction with all eight valves "taking as a base *Chiton loftu-*

*sianus.*" No mention is made of end valves. Woodward (1865) thought *C. wrightianus* was a cirripede of the genus *Turrilepas,* a view with which Rochebrune (1883) agreed and which Withers (1926) confirmed.

### *yochelsoni,* Hoare and Smith, 1984, *Soleachiton*

*Soleachiton yochelsoni* Hoare and Smith, 1984:90–92, fig. 4 (reconstruction), 5A–V [type species of *Soleachiton* Hoare and Smith, 1984, by original designation].

Geological Age.—Lower and Middle Permian (Wolfcampian, Leonardian).

Localities.—USA: Texas, Leonard Formation, USNM loc. 702; Road Canyon Formation, USNM loc. 703a; Cathedral Mountain Formation, USNM locs. 703a', 703bs; Bone Spring Formation, USNM loc. 725d, Glass Mts., West Texas.

Location of Material.—Holotype, USNM-330848; paratypes, USNM-330849–330862.

Remarks.—A reconstructed specimen measures approximately 23 mm in length and 10 mm in width with a length to width ratio of 2.3:1. The head valve is known from only a fragmentary specimen. The intermediate valves are high-arched (jugal angle averaging 103°), swept-wing, and mucronate with the apical angle averaging 98°. The side-slopes are slightly convex with no differentiation of lateral and central areas. The sutural laminae are small, short, and rounded. The tail valves are triangular in plan view, high-arched, with a terminal mucro overhanging the posterior margin. Fine ridges radiate from the mucro on some specimens. Ventrally, the posterior portion is a hypotyche forming a posterior pocket and the sutural laminae are broad, short, and rounded. No definite ornamentation or sculpture is present, the valve surfaces being smooth.

Average dimensions are (mm):

| | Intermediate | Tail |
|---|---|---|
| Length | 4.4 | 4.7 |
| Width | 5.9 | 4.7 |
| Height | 3.0 | 2.8 |

The new genus *Soleachiton* Hoare and Smith, 1984 was erected to contain those species with triangular tail valves having a terminal mucro, and possessing a hypotyche on the ventral surface of the valve. The family Acutichitonidae Hoare, Mapes, and Atwater, 1983, containing the genus *Acutichiton* Hoare, Sturgeon, and Hoare, 1972 and *Arcochiton* Hoare and Sturgeon, 1976, would appear to be the logical familial assignment for *Soleachiton.*

### *youngianus* (Kirkby *in* Young, 1865), *Glyptochiton*

*Chitonellus youngianus* Kirkby *in* Young, 1865:14–15, pl. fig. 2. Kirkby and Young 1867:341–342, pl. 16, fig. 2–4. Young 1878:324. Etheridge 1882:101–102, pl. 2, fig. 23–24.

*Chiton youngianus* (Kirkby *in* Young). Rochebrune 1883:33–34 (see "*yungianus*").

*Glyptochiton youngianus* (Kirkby *in* Young). Smith 1960:172, fig. 44,6a–b (ex Etheridge). Smith 1971:567, 572. Sirenko and Starobogatov 1977:37.

Geological Age.—Lower Carboniferous (Main or Hurlet Limestone).

Localities.—Western Scotland: Craigenglen, Campsie, Ayrshire, in marine shale (Kirkby); Cunningham Baidland, near Dalry (Etheridge).

Location of Material.—Collection of J. Armstrong (fide Etheridge). Present location unknown.

Remarks.—The species is based on a single tail valve and two probable intermediate valves. The illustrations show an oval or ovate tegmentum, beaded circularly, with an elongate-ovate, smooth center. The articulamentum is extensively developed anteriorly, with a fairly deep sinus. Dimensions of one of the intermediate valves is given as: length, $^{9}/_{32}$ in. (7 mm); breadth, $^{4}/_{32}$ in. (3.2 mm). Kirkby's description seems quite complete as it covers all significant details.

Kirkby and Young (1867) reported the collection of portions of two intermediate valves, which they described and illustrated. A third valve collected was lost.

Etheridge (1882) described and illustrated a well-preserved tail valve that seemed to him to exhibit characters of both *Chitonellus subquadratus* Kirkby and Young, 1867 and *C. youngianus.* He indicated that possibly the two species were conspecific, and also called attention to the fact that one of de Ryckholt's illustrations of *C. cordifer* (1845, pl. 4, fig. 10) was much like the tail valve of *C. youngianus.*

This species has been assigned subsequently to the genus *Glyptochiton* de Koninck, 1883 with *G. cordifer* (de Koninck, 1844) as type; other related species include *G. subquadratus* and *G. kirkbyanus* (Etheridge, 1882).

## Recorded but Unnamed Paleozoic Species

The following citations are included in order to have a record of miscellaneous undetermined

polyplacophoran valves that have been noted in the literature, or that have been brought to the attention of the writers. It is hoped that a listing of the localities will result in additional collecting and thus produce valuable material for future study.

Genus and species indeterminate Smith *in* Smith and Toomey, 1964:31, pl. 8, fig. 1–3.

GEOLOGICAL AGE.—Lower Ordovician (Kindblade Formation).
LOCALITY.—USA: Oklahoma, Arbuckle Mts. (See *Gotlandochiton hami* Smith *in* Smith and Toomey, 1964).
LOCATION OF MATERIAL.—OU-5231.

REMARKS.—A single, poorly-preserved intermediate valve, referable with some doubt only to the family Gotlandochitonidae.

"*Chiton*" sp. de Koninck, 1857:196. Baily 1859: 333; 1860:95.

GEOLOGICAL AGE.—Middle Devonian.
LOCALITY.—England: Plymouth.
LOCATION OF MATERIAL.—Said to be based on material in the Geological Survey Collection, London.

"*Chiton*" sp. nov. Kirkby, 1862:236.

GEOLOGICAL AGE.—Carboniferous (Lower Scar).
LOCALITY.—England: Settle, Yorkshire, near the base of the Lower Scar subdivision of the Mountain Limestone.
LOCATION OF MATERIAL.—Unknown.

REMARKS.—Found along with *Chiton burrowianus* Kirkby, 1862, *C. coloratus* Kirkby, 1862, and valves of a couple of other species not named by Kirkby at the time. Kirkby said: "Besides the preceding plates, there is a cast of a patelliform shell among Mr. Burrow's specimens that may be a plate of a *Chiton* or *Chitonellus*. It is ¾ inch [19 mm] long, rather convex, and slightly flanged marginally; and a posterior plate of an undoubted Chiton rests upon one side of it. I do not describe it with the other plates, because I cannot detect traces of apophyses, nor satisfy myself as to its shell-structure, nor yet perceive anything conclusive of its relation to this family" (1862: 236).

"*Chiton*" sp. Richter, 1863.

GEOLOGICAL AGE.—Middle Devonian.
LOCALITY.—Germany.
LOCATION OF MATERIAL.—Unknown.

REMARKS.—Based on a reference by Rochebrune (1883:23–24). According to Rochebrune, Richter cited a polyplacophoran in a long list of Devonian fossils from the pflanzen Sandstein but did not describe or illustrate it. He said it was the same as another unnamed polyplacophoran from the Devonian of Plymouth, England, to which a vague reference was made by Bigsby (1878:319) and also in the 4th volume of the Memoirs of the Geological Survey.

The reference to the Richter paper to which Rochebrune refers was not located.

"*Chiton*" sp. Etheridge, 1882:91–92, pl. 1, fig. 16–17.

GEOLOGICAL AGE.—Lower Carboniferous.
LOCALITY.—Scotland: Gallowhill, near Strathaven, Lanarkshire.
LOCATION OF MATERIAL.—Collection of J. Thompson (fide Etheridge). Present location unknown.

REMARKS.—The specimen is a single, moderately large intermediate valve. No dimensions are given. Etheridge compared it with *Chiton gemmatus* de Koninck, 1842:323, pl. 23, fig. 2c [=*C. subgemmatus* d'Orbigny, 1850:127] and points out several important differences, one being the much narrower and stronger sutural laminae, which "project more from the front."

"*Chiton*" sp. indet. Etheridge, 1882:92, pl. 2, fig. 10.

GEOLOGICAL AGE.—Lower Carboniferous (Main or Hurlet Limestone).
LOCALITY.—Scotland: near Dalry, Ayrshire, from the Law Quarry.
LOCATION OF MATERIAL.—Collection of J. Armstrong (fide Etheridge). Present location unknown.

REMARKS.—Based on a fragment of what Etheridge thought might be an intermediate valve, which has a single most peculiar spike or tooth-like apophysis. This certainly is not like the sutural lamina on any fossil polyplacophoran and its identification as a polyplacophoran rests on extremely doubtful grounds.

"*Chiton*" sp. indet. Etheridge, 1882:95, pl. 1, fig. 23–24.

GEOLOGICAL AGE.—Lower Carboniferous (Main or Hurlet Limestone).
LOCALITY.—Scotland: near Dalry, Ayrshire, from the Law Quarry.
LOCATION OF MATERIAL.—Collection of J. Smith (fide Etheridge). Present location unknown.

REMARKS.—Based on one or two valves that

are said to be different from those of other British Carboniferous species. Etheridge said the head valve comes closest to his *Chiton geikiei* without the marginal projections characteristic of this species. The dorsal sculpture consists of microscopic granulations. The sutural laminae are small and rather pointed.

The material is too meager for more than a casual reference to fossil valves that subsequently may be determined as coming within the range of variation of an already described species.

"*Chiton*" sp. Reed, 1907:114, pl. 4, fig. 13–14.

Geological Age.—Silurian (Upper Bala).
Locality.—Scotland: Girvan area, Penwhipple and Thraive glens.
Location of Material.—BM (N.H.) (fide H. W. Ball).

Remarks.—The illustrations look like an elongate intermediate valve of a species of *Chelodes*.

*Chelodes*? sp. indet. Bergenhayn, 1960:175, fig. 17–18.

Geological Age.—Lower Ordovician.
Locality.—USA: Missouri.
Location of Material.—USNM-137378.

Remarks.—Based on a tail valve and an impression of another tail valve, too poorly preserved for identification to species. Found with *Chelodes depressus* Bergenhayn, 1960.

*Priscochiton*? sp. indet. Bergenhayn, 1960:175, fig. 19–20.

Geological Age.—Upper Cambrian (lower "Ozarkian").
Locality.—USA: New York, on south side of a hill north of Mrs. Josie A. Hall's house, Whitehall, Washington County.
Location of Material.—USNM-137377.

Remarks.—Based on a supposed tail valve 7 mm long and 4 mm wide, with the lateral slopes weakly concave, forming a jugal angle of 120°. The mucro is far back, the posterior part of the valve weakly concave. This is certainly not applicable to the genus *Priscochiton* as represented by *P. canadensis* (Billings, 1865), and its assignment as a polyplacophoran is doubtful.

*Ivoechiton* sp. Smith *in* Smith and Toomey, 1964: 23, pl. 4, fig. 16–18.

Geological Age.—Lower Ordovician (Kindblade Formation).
Locality.—USA: Oklahoma, Murray County, 9.7 km west-southwest of Mill Creek village (SW¼ SW¼, sec. 17, T 2S, R 4E), Mill Creek section, in a zone of abundant *Calathium*, 37.2 m above the base of the Kindblade Formation.
Location of Material.—OU-5222.

Remarks.—A single intermediate valve, almost square, measures 7.8 mm long, 7.9 mm wide, and 3.0 mm high, with a jugal thickness of 1.5 mm. The angle of divergence of the side-slopes is about 120°. This has some aspects of *Ivoechiton oklahomensis* Smith, 1964 but differs from all other valves found in the Mill Creek section.

*Kindbladochiton* sp. Smith *in* Smith and Toomey, 1964:27–28, pl. 6, fig. 10–12.

Geological Age.—Lower Ordovician (Kindblade Formation).
Locality.—USA: Oklahoma, Murray County, 9.7 km north of Woodford, on the original Joins Ranch (SE¼ NW¼ NE¼, sec. 4, T 2S, R 1W), Joins Ranch section, in a zone of abundant *Calathium*, 460–500 feet above the base of the Kindblade Formation.
Location of Material.—OU-5218.

Remarks.—Based on a single specimen consisting of two separate valves fused into one, more likely the result of injury while living and less likely due to an artifact of fossilization. Found with *Kindbladochiton arbucklensis* (Smith, 1964), to which it appears to be related.

*Gotlandochiton* sp. Smith *in* Smith and Toomey, 1964:30–31, pl. 17, fig. 16–18.

Geological Age.—Lower Ordovician (Kindblade Formation).
Locality.—USA: Oklahoma, Murray County, 9.7 km west-southwest of Mill Creek village (SW¼ SE¼, sec. 17, T 2S, R 4E), Mill Creek section, in a zone of abundant *Calathium*, 37.2 m above the base of the Kindblade Formation.
Location of Material.—OU-5228.

Remarks.—A single intermediate valve, 5.5 mm long, 10.8 mm wide, and 4.2 mm high, with a maximum jugal thickness of 1.1 mm, and an angle of divergence of the side-slopes of about 108°. It is related to *Gotlandochiton hami* Smith, 1964, but more specimens like it are needed to establish its species identity.

Family Lepidopleuridae, no genus or species indicated. Batten 1972:10, fig. 1–2.

Geological Age.—Permian.
Locality.—Lee Mine No. 8, Kampar, Perak, Malaysia, *Misellina claudiae* Zone.
Location of Material.—American Museum of Natural History, New York, AMNH-29023–29024.

REMARKS.—Available material consists of six valves (three well-preserved and three poorly preserved) of which two are intermediate valves and four are end valves. Figure 1 is of a well-preserved tail valve with a central mucro and a rather fine, closely spaced granular sculpture. Possibly it can be referred to the genus *Pterochiton,* s.l. Figure 2 represents an end valve front view, showing no especially definitive shape or sculpture.

"*Chiton*?" sp. Weller, 1903:173–174, pl. 13, fig. 1–10.

GEOLOGICAL AGE.—Middle Ordovician (Trenton Limestone).

LOCALITY.—USA: Jacksonburg, New Jersey.

LOCALITY OF MATERIAL.—Holotype in New Jersey Geological Survey Collection (Paleontology). Plastotype in Walker Museum Collection, University of Chicago, New Jersey Collection, Paleontology Collection No. 10239 [now in Field Museum of Natural History, Chicago].

REMARKS.—Weller's description follows:

> A single plate, probably the posterior terminal one, has been observed in the New Jersey collections, which probably belongs to one of the Chitons. Its true generic reference is uncertain, but doubtless it is not a member of the recent genus *Chiton.* It is subpentagonal in outline, obtusely angular in front, its posterior margin slightly sinuate. Along the median line it is quite sharply rounded toward the apex, but becomes more broadly rounded posteriorly, with a slight, longitudinal, median groove, becoming stronger posteriorly. The sides slope down to the lateral margins with a gentle convexity. The surface is smooth.
>
> Its dimensions are: length, 7 mm; breadth, 7 mm.

The plastotype of the holotype, at present in the Field Museum of Natural History, Chicago, was loaned for study through the courtesy of Gerald Forney, Department of the Geophysical Sciences, University of Chicago. Although stated by Weller to be a tail valve, it more likely represents an intermediate valve slightly longer than wide (7.3 mm long compared with the 7.0 given by Weller). The aspect is swept-wing, with the posterior margins angled forward approximately 70° from the valve apex. The anterior margin is indented by a shallow sinus. The valve is gently round-backed, with an indication of a subobsolete jugal ridge; otherwise there is no evidence of a separation into lateral or lateropleural areas. Also, there is no evidence of the presence of sutural laminae. The ventral side is not exposed.

This fossil polyplacophoran cannot be allocated to a family on the basis of an investigation of the plastotype. Study of the holotype specimen is necessary before any judgment can be made regarding its systematic position.

Genus and species unknown. Cloud and Barnes 1946:282, 365.

GEOLOGICAL AGE.—Lower Ordovician.

LOCALITY.—USA: Texas, El Paso and Tomyard formations, Ellenberger Group. Moore Hollow section and Franklin Mts. section (Cloud and Barnes).

LOCATION OF MATERIAL.—Unknown.

REMARKS.—Mentions presence of polyplacophoran plates in the Ellenberger Group. No description or illustrations given.

"*Chiton*" sp. Mendes, 1952:302.

GEOLOGICAL AGE.—Permian.

LOCALITY.—Brazil. Locality unknown.

LOCATION OF MATERIAL.—Unknown.

REMARKS.—One valve of a polyplacophoran reported. No description or illustrations.

Unknown genus and species, Plas, 1972:252–253.

GEOLOGICAL AGE.—Lower Permian (Bird Spring Group).

LOCALITY.—USA: Nevada. Arrow Canyon Range, Arrow Canyon Quadrangle, southeastern Nevada.

LOCATION OF MATERIAL.—Unknown.

REMARKS.—More than 40 valves of a new genus and species of polyplacophoran extracted from limestone of Unit I by acidization. Not figured or described. Tail valve is concave in lateral outline.

*Helminthochiton* sp. Plas, 1972:252–253.

GEOLOGICAL AGE.—Lower Permian (Bird Spring Group).

LOCALITY.—USA: Nevada. Arrow Canyon Range, Arrow Canyon Quadrangle, southeastern Nevada.

LOCATION OF MATERIAL.—Unknown.

REMARKS.—Three or four valves of what is probably a *Gryphochiton* extracted from limestone of Unit I by acidization. Not figured or described.

*Pterochiton* sp. A, Hoare and Sturgeon, 1979: 179, pl. 2, fig. 10–11.

GEOLOGICAL AGE.—Upper Pennsylvanian (Missourian).

LOCALITY.—USA: Ohio. Brush Creek Shale at road-cut exposure on Ohio Rte. 13, 1.3 km north of Glocester, Athens Co., Ohio.

LOCATION OF MATERIAL.—Hypotype, OSU-30353.

REMARKS.—One small, incomplete, tail valve

which appears close to *Glaphurochiton carbonarius* (Stevens, 1858) but has a finer surface ornamentation of granules. Additional material is needed to make a valid comparison with *G. carbonarius*.

Indeterminate lepidopleurid genus and species A, Hoare and Smith, 1984:100–101, fig. 9K–N.

Geological Age.—Middle Permian (Leonardian).

Locality.—USA: Texas, Road Canyon Formation, USNM loc. 703c, Glass Mts., West Texas.

Location of Material.—Hypotype, USNM-330894.

Remarks.—One nearly complete intermediate valve. Valve highly arched, twice as wide as long, with straight side-slopes which are not divided into lateral and central areas. The sutural laminae are short and broad. The jugal angle measures 86° and the apical angle 110°. The surface is ornamented with fine ridges radiating from the mucronate apex and on the side-slopes the closely spaced ridges are sinuous, running horizontally. The valve measures (mm): length, 4.5; width, 9.5; height, 5.6.

Indeterminate lepidopleurid genus and species B, Hoare and Smith, 1984:101, fig. 9O.

Geological Age.—Middle Permian (Leonardian).

Locality.—USA: Texas, Road Canyon Formation, USNM loc. 721j, Glass Mts., West Texas.

Location of Material.—Hypotype, USNM-330895.

Remarks.—A fragmentary intermediate valve that is short, with a ridge radiating from the apex separating distinct lateral and central areas. Surface marked by prominent growth lines. Sutural laminae very broad and rounded.

Indeterminate lepidopleurid genus and species C, Hoare and Smith, 1984:101, fig. 9P–V.

Geological Age.—Middle Permian (Leonardian).

Localities.—USA: Texas, Road Canyon Formation, USNM loc. 721j; Cathedral Mountain Formation, USNM loc. 709, Glass Mts., West Texas.

Location of Material.—Hypotypes, USNM-330880–330881.

Remarks.—Two intermediate valves incomplete along posterior margins. Valves slightly wider than long, low-arched with nearly straight side-slopes which are not divided into lateral and central areas. Possible false beak present. Sutural laminae short and broad. Jugal angle measures 115°. Surface ornamented with fine, closely spaced granules arranged in curved longitudinal rows. The most complete valve measured (mm): length, 7.0; width, 10.8; height, 4.0.

## Annotated Bibliography


Ashby, E. 1929. Notes and additions to Australian fossil Polyplacophora (chitons). Proc. Royal Soc. Victoria, n.s. 41(2): 220–230, pl. 24. [See pp. 228–229 for classification.]

Baily, W. H. 1859. On the occurrence of detached plates of the shell of a new species of *Chiton* in the Carboniferous limestone at Lisbane, County of Limerick. Nat. Hist. Review and Quart. J. Sci. 6:330–334, pl. 28, fig. 2a–c. [Also: J. Geol. Soc. Dublin 8:167–171, pl. 4, fig. 2a–c, 1860. Describes *Chiton thomondiensis* and lists 39 species of fossil chitons "at present known."]

———. 1860. Observations on two new species of *Chiton* from the Upper Silurian "Wenlock Limestone" of Dudley. Ann. and Mag. of Nat. Hist., ser. 3, 6(32):91–98, pl. 2, fig. 1a–d, 2a–c. [An English translation of de Koninck, 1857, q.v., with additional footnotes. Lists 35 species known to 1860.]

Barrande, J. 1867. Système Silurien du centre de la Bohême. Première partie: recherches paléontologiques, tom. 3. Classe des Mollusques. Ordre des Ptéropodes. Pp. i–xv, 1–179, pl. 1–16. Prague and Paris. [See Appendix, p. 175, pl. 16, fig. 19–28b for *Chiton bohemicus*.]

Barrois, C. E. 1889. Faune du calcaire d'Erbray. Soc. Geol. Nord, Mem. 3:181, 182, pl. 15, fig. 15a–c. [Describes *Helminthochiton lebescontei*.]

Batten, R. L. 1972. Permian gastropods and chitons from Perak, Malaysia. Pt. 1: chitons, bellerophontids, euomphalids and pleurotomarians. Bull. Am. Mus. Nat. Hist. 147(1): 10, fig. 1–2. [Describes occurrence of three valves and illustrates two of them.

Bergenhayn, J. R. M. 1930. Kurze Bemerkungen zur Kenntnis der Schalenstrucktur und Systematik der Loricaten. Kungl. Svenska Ventenskapsak., Handl., ser. 3, 9(3):1–54, pl. 1–10. [Gives a classification of Recent and fossil polyplacophorans.]

———. 1943. Preliminary notes on the fossil polyplacophoras from Sweden. Geol. Fören. I Stockholm, Förh. 65(3): 297–303, text-fig. 1–3. [Describes a new order (Chelodina), two new families (Chelodidae, Scanochitonidae), two new genera (*Scanochiton, Olingechiton*), and two new species.]

———. 1945. A new Carboniferous *Lepidopleurus* from Scotland. Geol. Fören. I Stockholm, Förh. 67(3):389–392, fig. 1–4. [Describes *Lepidopleurus laterodepressus*.]

———. 1955. Die Fossilen Schwedischen Loricaten nebst einer vorläufigen Revision des Systems der ganzen Klasse Loricata. Lunds Univ. Arsskrift, n.f., vd. 2, bd. 51, nr. 8. Kungl. Fysiogr. Sällskapets, Handl., n.f. 66(8):1–41, pl. 1–2. [See pp. 40–41 for complete classification of fossil and Recent forms down to and including genera.]

———. 1960. Cambrian and Ordovician loricates from North America. J. Paleontol. 34(1):168–178, text-fig. 1–20. [First published record of Cambrian polyplacophorans. Describes one new family (Preacanthochitonidae), one new genus (*Preacanthochiton*), and several new species. Repeats 1955 classification with additions and revisions.]

Bigsby, J. J. 1878. Thesaurus devonico-carboniferus, pp. 318, 319. John Van Voorst, London. [Lists 22 species previously described from Europe and 2 from North America.]

Billings, E. 1865. Paleozoic fossils, Vol. 1, containing de-

scriptions and figures of new or little known species of organic remains from the Silurian rocks, 1861–1865. Geol. Surv. Canada p. 394, fig. 37a–c. [*Chiton canadensis.*]

Bischoff, G. C. O. 1981. *Cobcrephora* n.g., representative of a new polyplacophoran order Phosphatoloricata with calciumphosphatic shells. Senckenbergiana Lethaea 61:173–215, pl. 1–7, text-fig. 1–6.

Blainville, H. M. D. de. 1816. Prodrome d'une nouvelle distribution systématique du règne animal. Bull. Sci. Soc. Philomat. pp. 105–124. Paris.

———. 1825. Manuel de malacologie et de conchyliologie, *Polyplaxiphora,* pp. 601–603, Atlas, pl. 87, F. G. Levrault, Paris.

Brady, L. F. 1955. Possible nautiloid mandibles from the Permian of Arizona. J. Paleontol. 29(1):102–104, pl. 21, fig. 2–8.

Branson, C. C. 1948. Bibliographic index of Permian invertebrates. Geol. Soc. Amer. Mem. 26:760–761.

Bronn, H. G. 1848. Index Palaeontologicus oder Übersicht der bis jetzt bekannten fossilen Organismen. 1st Abth., A, Nomenclator palaeontologicos, 1st Hälfte, *Chiton,* pp. 291–292. E. Schweizerbart, Stuttgart. [Also in later editions. Species references in synonymies are based on the 1848 edition, which lists 30 fossil species.]

Burrow, E. I. 1815. Elements of conchology, according to the Linnean system, illustrated by 28 plates, drawn from nature. Ogles, Duncan and Cochran, London. 248 pp.

Butts, C. 1926. Explanatory text to accompany the geological map of the state—the Paleozoic rocks. Geol. Surv. Ala., Spec. Rept. 14:99, 100, 125, 126, pl. 18, fig. 30–31; pl. 31, fig. 7. [Lists and illustrates *Priscochiton*? *mirabilis* and *P.*? *sellaeformis.*]

———. 1941. Geology of the Appalachian Valley in Virginia, Pt. 2. Va. Geol. Surv. Bull. 52:19–20, pl. 68, fig. 6. [Describes *Hemithecella expansa.*]

Chenu, J. C. 1859. Manuel de conchyliogie et de paléontologie conchyliologique, Vol. 1, p. 379, fig. 2852. [Reference to *Chiton priscus* Münster.]

Clarke, J. M. 1885. Die Fauna des Ibergerkalkes. Neues Jahrbuch für Mineralogie, Geologie und Paläontologie. III. Beilage-Band, pp. 337–340, pl. 4, fig. 12–20. Stuttgart. [Seven species are covered.]

———. 1907. Some new Devonic fossils. New York State Mus., Bull. 107(12):194–195, 2 text-fig. [Describes *Probolaeum*? *canadense* from the Lower Devonian of Quebec.]

Cloud, P. E. and V. E. Barnes. 1946. The Ellenburger group of central Texas. Univ. Texas Publ. 4621:140, 282, 365. [Mentions Lower Ordovician polyplacophoran plates, with no descriptions or figures.]

Collett, J. 1879. Geological report on Harrison and Crawford counties, Indiana, 1878. Ind. Geol. Surv., 8th–10th Annual Reports, 1876–78, p. 327. [Lists *Chiton carbonarius* Stevens.]

Cossmann, A. E. M. and G. Pissaro. 1912. Revue critique de paléozoologie, Vol. 16, p. 217. [Refers to Raymond (1910) on *Glaphurochiton* (sic. = *Glaphyrochiton*).]

Cotton, B. C. 1964. South Australian Mollusca—chitons—handbook of the flora and fauna of South Australia, issued by the South Australian Branch of the British Science Guild, Chap. 7, Fossil chitons, pp. 119–140, fig. 127–139, Adelaide. [Lists 76 names of which 65 are accepted as distinct species.]

Cotton, B. C. and F. K. Godfrey. 1940. The molluscs of South Australia—Australian fossil chitons. Handbook of the South Australian Museum, pt. II, p. 569–590, text-fig. 577–589. British Association for the Advancement of Science, Adelaide. [Describes one new genus (*Lavenachiton*) and four new species. Gives a classification of fossil chitons. Lists 66 Australian fossil species by geological age excluding the Pleistocene. Notes only *Permochiton australianus* from the Paleozoic.]

Cumings, E. R. 1906. Fauna of the Salem Limestone—Gasteropoda, Cephalopoda and Trilobita. Ind. Geol. Surv., 30th Annual Report, 1905, pp. 1365–1366, pl. 24, fig. 8–8c. [Mentions *Gryphochiton*(?) *parvus* (Stevens).]

Dall, W. H. 1879. Report on the limpets and chitons of the Alaskan and Arctic regions, with descriptions of genera and species believed to be new. Scientific Results of the Exploration of Alaska, Art. 4, p. 97. [Also in: Proc. U.S. Nat. Mus. 1:315 (1878). Brief mention of Paleozoic genera.]

———. 1882. On the genera of chitons. Proc. U.S. Nat. Mus. 4:279–291 (1881). [Discusses Paleozoic chitons described up to 1873. Important for type designations.]

Davidson, T. and W. King. 1874. On the Trimerellidae, a Paleozoic family of the palliobranchs or Brachiopoda. Quart. J. Geol. Soc. London 30(2):124–172, pl. 18, fig. 14, 14a–c. [Describes *Chelodes bergmani* n. gen., n. sp.]

DeBrock, M. D., R. D. Hoare, and R. H. Mapes. 1984. Pennsylvanian (Desmoinesian) Polyplacophora (Mollusca) from Texas. J. Paleont. 58(4):1117–1135, fig. 1–10. [Describes the new genera and species *Camptochiton squarrosus, Pedanochiton discomptus, Pileochiton cancellus,* and *Coryssochiton parallelus* and the species *Helminthochiton simplex* (Raymond), *Pterochiton spatulatus* Hoare, Sturgeon, and Hoare, *Acutichiton pyrmidalus* Hoare, Sturgeon, and Hoare and *Arcochiton raymondi* Hoare and Sturgeon.]

Dechaseaux, C. 1952. Classe de Amphineures. Pp. 214–215, fig. 3–4 *in* Traité de paléontologie, Vol. 2, J. Piveteau, ed. Masson et Cie., Paris. [Brief discussion of the distribution by geological age. Estimates the occurrence of about 250 fossil species.]

Dunlop, R. 1915. Notes on the discovery of fossil chitons in Fife. Trans. Geol. Soc. Glasgow 15(2):167–173, pl. 22, fig. 1–6. [Describes *Chiton woodmillensis.* Discusses and figures three other Carboniferous species.]

———. 1922. Notes on the chitons of Woodmill. Trans. Geol. Soc. Glasgow 17:75–76, text-fig. 1. [Comments on the collection of over 80 valves in a small area, comprising three species.]

Eberzin, A. G. 1960. Mollusca—Loricata, Bivalvia and Scaphopoda. Fundamentals of paleontology, Vol. 3, Loricata, pp. 15–17, text-fig. 1. Academy of Sciences of the USSR, Moscow. In Russian. [Brief mention of fossil species with a figure of *Helminthochiton,* presumably *H. priscus* (Münster).]

Eichwald, E. d'. 1860. Lethaea Rossica ou Paléontologie de la Russie, Vol. 1, sec. 3, p. 1093. Stuttgart. [Mentions *Chiton priscus* Münster.]

Etheridge, R., Jr. 1882. A contribution to the study of the British Carboniferous Chitonidae. Proc. Nat. Hist. Soc. Glasgow 5:84–107, pl. 1–2. [Describes seven new species; covers eight others, with figures.]

———. 1897. On the occurrence of the genus *Chelodes,* Davidson and King, in the Upper Silurian of New South Wales. Records of the Geological Survey of New South Wales, Vol. 5, pt. 2, pp. 67–70, text-fig. A–F. [Describes *Chelodes calceoloides.*]

Fischer, P. 1885. Manuel de conchyliologie et de paléontologie conchyliogique ou histoire naturelle des mollusques

vivants et fossiles—Ordre des Polyplacophora. Pp. 870–884, text-fig. 613–625, pl. XI, fig. 28–31. [For comment on Fischer's classification, see Pilsbry, 1892, Manual of conchology, Vol. 14, p. xxi.]

Fischer, P.-H. 1957. Revision des Amphineures de la Collection de l'Ecole des Mines de Paris. J. Conchyl. 97(1):10–24. [Lists 16 fossil species. This collection includes de Koninck's from the Paleozoic, Bourdot's from the Tertiary, and Deshayes's from the Recent. It would appear that some of Rochebrune's Eocene species from the Paris Basin are here also. Much of the material has been figured by Cossmann (1888) and by Cossmann and Pissaro (1910–1913).]

Fisher, D. W. 1962. Small conoidal shells of uncertain affinities. Pp. 98–143 *in* Treatise on invertebrate paleontology, Pt. W, Miscellanea, R. C. Moore, ed. Geol. Soc. America and Univ. Kans. Press, Lawrence, Kansas.

Flower, R. H. 1968. Some El Paso guide fossils. New Mexico Instit. Mining and Tech., Mem. 22, pt. 1, pp. 1–19, pl. 1, fig. 1–24. [Describes *Calceochiton hachitae* n. sp. (type of *Calceochiton* n. gen.) and *C.* cf. *C. gibberosum* (Sardeson).]

Foster, J. W. 1837. Miscellaneous observations made during a tour in May, 1835, to the Falls of the Cuyahoga [Ohio], near Lake Erie: extracted from the diary of a naturalist. Amer. J. Sci. 31(1):82–84, fig. 20. [Describes *Chiton occidentalis* with 10 valves; a cephalopod not a polyplacophoran.]

Fraas, E. 1910. Der Petrefaktensammler. Schriften der Deutschen Lohrerver für Naturwissenschaft, Bd. 25, p. 83, fig. 55. Stuttgart. [Fig. 55 is of *Gryphochiton priscus* (Münster).]

Frederickson, E. A. 1956. Rare fossil chiton from Ada, Oklahoma. Okla. Geology Notes, Okla. Geol. Surv. 16(7): 65–66, fig. 1. [Notice of a new *Helminthochiton* with valves *i–vi*, inclusive, in place.]

———. 1962. *Helminthochiton* from the Pennsylvanian of Oklahoma, Okla. Geology Notes, Okla. Geol. Surv. 22(11): 298–302, fig. 1–3. [Describes *Helminthochiton riddlei.*]

Geinitz, H. B. 1846. Grundriss der Versteinerungskunde, Vol. 1, Fam. Chitonidae, p. 389, pl. 5, fig. 13–14. Dresden and Leipzig. [Reference to *Chiton priscus* Münster and ?*C. cottae* Geinitz.]

———. 1861. Die animalischen Ueberreste der Dyas. Dyas oder de Zechsteinformation und das Rothliegende, Heft. 1, pp. 53–56, text-fig. VI(1–10), VII(1–11), VIII(1–10). Leipzig. [Comments on seven species, including *Chiton cottae.*]

Girty, G. H. 1909. The Guadalupian fauna. U.S. Geol. Surv. 58:450–451, pl. 29, fig. 21, 21a. [For *Cymatochiton*? *texanus* n. sp. from the Texas Permian.]

Gortani, M. 1913. La Serie Devoniana nella Giogaia del Coglians (Alpi Carniche). Bolletino Roma Comitato Geologico d'Italia, ser. 5, 43:262, pl. 3, fig. 13a–b (1912). [Describes *Chiton collinensis* from the Upper Devonian of Austria.]

Gray, J. E. 1847*a*. On the genera of the family Chitonidae. Proc. Zool. Soc. London, pt. 15, no. 174, p. 70. [Describes the genus *Gryphochiton.*]

———. 1847*b*. A list of the genera of Recent Mollusca, their synonyms and types. Proc. Zool. Soc. London, pt. 15, no. 178, p. 169. [*Chiton nervicanus* de Ryckholt, 1845 designated as type species of *Gryphochiton* Gray, 1847.]

Gürich, G. 1929. *Silesicaris* von Leipe und die Phyllokariden überhaupt. Mitteil. Mineral-geol. Staatsinst. Hamburg 11:49. [Compares *Anatifopsis*? *elongata* with *Solenocaris.*]

Hadding, A. 1913. Undre Dicellograptusskiffern i Skåne jämte några därmed ekvivalenta bildningar. Lunds Univ. Årsskrift, n.f. 2, 9(15):67, pl. 4, fig. 34. [Describes *Anatifopsis*? *elongata.*]

———. 1915. Der mittlere *Dicellograptus* Schiefer auf Bornholm. Lunds Univ. Årsskrift, n.f. 2, 11(4):31, pl. 4, fig. 27. [Describes *Anatifopsis*? *elongata.*]

Herrmannsen, A. N. 1852. Indicis generum malacazoorum primordia. Supplementa et corrigenda, p. 58. Cassellis, London and Paris. [Mentions genus *Gryphochiton,* type *G. nervicanus.*]

Hoare, R. D. 1975. Selection of neotype specimen for *Chiton carbonarius* Stevens (Mollusca, Polyplacophora). Ohio J. Sci. 75(5):223–224, fig. 1–3.

———. 1976. *Lobarochiton,* new generic designation for *Gryphochiton*? *anomalus* (Rowley) (Polyplacophora). Ohio J. Sci. 76(3):116–118, fig. 1–3.

Hoare, R. D. and R. H. Mapes. 1985*a*. New Mississippian and Pennsylvanian Polyplacophora (Mollusca) from North America. J. Paleontol. 59(4):875–881, fig. 1–3. [Describes *Colapterochiton decorus* n. gen., n. sp.; *Elachychiton juxtaterminus* n. gen., n. sp.; and *Euleptochiton torus* n. gen., n. sp.]

———. 1985*b*. A new species of Pennsylvanian Polyplacophora (Mollusca) from Texas. J. Paleontol. 59(5):1324–1326. [Describes *Acutichiton pannuceus.*]

Hoare, R. D., R. H. Mapes, and D. E. Atwater. 1983. Pennsylvanian Polyplacophora (Mollusca) from Oklahoma and Texas. J. Paleontol. 57(5):992–1000, fig. 1–5. [Describes *Pterochiton carbonarius* (Stevens), *P. tholus* and *Acutichiton allynsmithi.* Proposed new family Acutichitonidae.]

Hoare, R. D. and A. G. Smith. 1984. Permian Polyplacophora (Mollusca) from West Texas. J. Paleontol. 58(1): 82–103, fig. 1–10. [Describes the new species *Helminthochiton girtyi* and the new genera and species *Ochmazochiton comptus, Chauliochiton knighti, Stegochiton coxi, S.*? *onerosus, Soleachiton yochelsoni, Lekiskochiton fornicis,* and three indeterminate genera and species. Proposed new family Ochmazochitonidae.]

Hoare, R. D. and M. T. Sturgeon. 1976. *Arcochiton raymondi* n. gen., n. sp. of polyplacophoran from the Pennsylvanian of Ohio. J. Paleontol. 50(5):841–845, pl. 1–2.

———. 1979. Stratigraphic distribution of Polyplacophora in the Mississippian and Pennsylvanian of North America. 8th Internat. Congr. Carb. Strat. and Geology, Compte Rendu 3:176–183, pl. 1–3. [Shows distribution of seven species.]

Hoare, R. D., M. T. Sturgeon, and T. B. Hoare. 1972. Middle Pennsylvanian (Allegheny Group) Polyplacophora from Ohio. J. Paleontol. 46(5):675–680, pl. 1–3. [Describes *Pterochiton carbonarius* (Stevens), *Helminthochiton simplex* (Raymond), *Pterochiton spatulatus* n. sp., *Acutichiton pyrmidalus* n. gen., n. sp.]

Howse, R. 1848. A catalogue of the fossils of the Permian System of the Counties of Northumberland and Durham. Trans. Tyneside Nat. Field Club 1:219–264. [Describes *Calyptraea antiqua* (=*Chiton antiquus*) Howse and *Chiton* sp.]

———. 1857. Notes on the Permian System of the Counties of Durham and Northumberland. Ann. and Mag. Nat. Hist., ser. 2, 19:426–476, pl. 4, fig. 16–17. [Also in: Trans. Tyneside Nat. Field Club 3:235–285, pl. 11 (1858). Discusses *Chiton loftusianus* King and *Calyptraea antiqua* Howse.]

Iredale, T. and A. F. B. Hull. 1926. A monograph of the Australian loricates, VIII, Appendix B, Paleoloricata. Austral. Zool. 4(5):324–328, pl. 45. [Reprinted in: Royal Zool.

Soc. New South Wales, pp. 139–143, pl. 18 (1927). A review of all Australian fossil species.]

JAEKEL, O. 1900. Über einem neuen Chitonida *Trachypleura* n.g. aus dem Muschelkalk von Rüdersdorf. Zeitschr. Deutsch. Geol. Gesell. 52:9–14, fig. 1–2. [Mentions *Chiton tornacicola* de Ryckholt and *C. scaldianus* de Ryckholt.]

JAHN, J. J. 1893. *Duslia* eine neue Chitonidengattung aus dem bömischen Untersilur, nebst einigen Bemerkungen über die Gattung *Triopus* Barrande. Sitzungberichte der mathematisch-naturwissenschaftlichen Klasse der Kaiserlichen Academie der Wissenschaften zu Wien, Abth. 2, Bd. 102, Heft 8, pp. 591–603, pl. 1, fig. 1–4. [Describes *Duslia insignis,* from the Lower Silurian of Bohemia.]

KINDLE, E. M. 1898. A catalogue of the fossils of Indiana. Ind. Dept. Geology and Nat. Resources, 22nd Ann. Rept. for 1897, p. 468. [Lists *Chiton carbonarius* Stevens.]

KING, W. 1844. The genus *Chiton* found in the Magnesian Limestone of Durham. Ann. and Mag. Nat. Hist., ser. 1 (new series) 14(92):381–382. [First report of the occurrence of a polyplacophoran in the Permian.]

———. 1846. On a Magnesian-Limestone species of *Chiton.* Charlesworth's London J. Geology 1:10–12, fig. 1–4.

———. 1848. A catalogue of the organic remains of the Permian rocks of Northumberland and Durham, 16 pp. William King, Newcastle-upon-Tyne. [Describes *Chiton loftusianus.*]

———. 1850. A monograph of the Permian fossils of England. Paleontogr. Soc., pp. 201–203, 247 (Appendix), pl. 16, fig. 9–14. [Describes *Chiton loftusianus;* comments on the validity of *Calyptraea antiqua* Howse.]

KIRKBY, J. W. 1857. On some Permian fossils from Durham. Quart. J. Geol. Soc. London 13:213–218, pl. 7, fig. 9–13. [Also in: Trans. of the Tyneside Nat. Field Club 3:286–294, pl. 12, fig. 9–13 (1858). Describes *Chiton howseanus.*]

———. 1859. On the Permian Chitonidae. Quart. J. Geol. Soc. London 15:607–626, pl. 16, fig. 1–52. [Also in: Trans. of the Tyneside Nat. Field Club 3:238–263, pl. 13, fig. 1–52 (1860). Describes *Chiton*? *cordatus, Chitonellus hancockianus,* and *C. distortus.* Lists and illustrates three other species.]

———. 1862. On some remains of *Chiton* from the Mountain-Limestone of Yorkshire. Quart. J. Geol. Soc. London 18:233–237, text-fig. 1–10. [Describes several new species from the Carboniferous of England and lists 15 other species from the Carboniferous of Europe.]

———. 1864. On some fossils from the Lower Magnesian Limestone of Sunderland. Trans. Tyneside Nat. Field Club 4:212–220. [Mentions *Chiton loftusianus*?.]

KIRKBY, J. W. AND J. YOUNG. 1867. Notes on some remains of *Chiton* and *Chitonellus* from the Carboniferous strata of Yorkshire and the west of Scotland. Geol. Mag. 4(38):340–343, pl. 16, fig. 1–17. [Describes nine species.]

KNORRE, H. VON. 1925. *Duslia insignis* Jahn—ein angeblich 11 oder 12 Schalenplatten tragender Chiton der untersilurischen Schichten Böhmens. Jenaische Zeitschrift für Naturwissenschaft, Bd. 61, pp. 497–499, text-fig. 1.

KONINCK, L. G. DE. 1842. Description des animaux fossiles, qui se trouvent dans le terrain carbonifère de Belgique. Le genre *Chiton* Linn., pp. 60–61, 319–324, pl. 22, fig. 4–5 and pl. 23, fig. 1–2. H. Dessain, Liege. [Describes *Chiton priscus* and the new species *C. concentricus, C. gemmatus,* and *C.*? *cordifer.*]

———. 1883. Faune du calcaire carbonifère de la Belgique, Pt. 4, Gastéropodes. Annales Musée Royale d'Histoire Naturelle de Belgique, sér. Paléont. 8(4):198–213, pl. 50–53. [Describes new genera *Rhombichiton* and *Glyptochiton* and describes 16 species.]

KONINCK, M. L. DE. 1857. Sur deux nouvelles espèces siluriennes appartenant au genre *Chiton.* Bulletin de l'Académie Royale des Sciences, des Lettres et des Beaux-Arts de Belgique 11:190–199, pl. 1, fig. 1a–d, 2a–c. Brussels. [Reviews existing knowledge of fossil chitons and lists them by geological age. Describes *Chiton grayanus* and *C. wrightianus.* See Baily (1860) for English translation.]

———. 1860. Observations on two new species of *Chiton* from the Upper Silurian "Wenlock limestone" of Dudley. Ann. and Mag. Nat. Hist., ser. 3, 6(32):91–98, pl. 2. [Describes *Chiton grayanus* and *C. wrightianus* and lists all known species to date.]

KUES, B. S. 1978. Polyplacophora from the Salem Limestone (Mississippian) in central Indiana. J. Paleontol. 52(2):300–310, pl. 1–2, text-fig. 1. [Describes *Pterochiton parvus* (Stevens) and *P. elevatus.*]

———. 1983. A chiton from the Flechado Formation (Middle Pennsylvanian) of northern New Mexico. New Mexico J. Sci. 23(1):19–21, 1 text-fig. [Describes an occurrence of *Pterochiton carbonarius.*]

LADD, H. S. 1925. The stratigraphy and fauna of the Maquoketa shale of Iowa. Univ. Iowa. Unpublished Ph.D. Thesis. [Notes *Ceratiocaris* cf. *C.* (*Limnocaris*) *praecedens* (=*Septemchiton iowensis*) from the Upper Ordovician, pp. 205–206, pl. 32, fig. 23–24.]

LAMARCK, J. P. D. M. DE. 1802. Mémoires sur les fossiles des environs de Paris, comprenant la détermination des espèces qui appartiennent aux animaux marins sans vertèbres et dont la plupart sont figurés dans la collection de vélins du Museum. Premier Mémoire, Genre I, Chiton. Oscabrion. Annales du Musée Nationale Naturelle, Vol. 1, p. 308. Paris. [First published account of a fossil chiton (*C. grignonensis*).]

LANG, V., J. MAREK, AND I. PEK. 1982. A find of the species *Rhombichiton laterodepressus* (Bergenhayn, 1945) in the Culm of the Drahanská vrchovina Upland. Vestnik Ústredního ústava geologického 57(5):299–302, pl. 1–2.

LESLEY, J. P. 1889. A dictionary of the fossils of Pennsylvania and neighboring states named in the reports and catalogues of the Survey. Pa. 2nd Geol. Surv., Rept. P4, vol. 1–3, 1283 pp.

LINDSTRÖM, G. 1884. On the Silurian Gastropoda and Pteropoda of Gotland. Chitonidae. Kongl. Svenska Vetenskaps-Akad., Handl. 19(6):48–52, pl. 2, fig. 1–27. Stockholm. [Gives reasons for including *Chelodes* in the Chitonidae. Describes *Chelodes gotlandicus.*]

LINNÉ, C. 1764. Museum Ludovicae Ulricae Reginae Suecorum, Gothorum, Vandalorumque . . . in quo animalia rariora, exotica, imprimis insecta & conchilia describuntur & determinantur. Direct. Laur. Salvii, Stockholm. 720 pp.

MCCOY, F. 1846. Synopsis of the Silurian fossils of Ireland. Addenda, p. 71, pl. 5, fig. 5a–e. [Describes *Helminthochiton griffithi* Salter.]

MAREK, L. 1962. New polyplacophorid family Eochelodidae n. fam. in the Ordovician of Bohemia. Vestnik Ústredního ústavu geologického 38:373–375, 1 pl., text-fig. 1. [Describes *Eochelodes bergenhayni.*]

MEEK, F. B. AND A. H. WORTHEN. 1873. Fossils of the Coal Measures. Geol. Surv. Ill. 5(2):560–619, pl. 29, fig. 15. [Describes *Chiton carbonarius* Stevens.]

MENDES, J. C. 1952. Invertébrés du système de Gondwana au Brésil. Pp. 302–307 *in* Symposium sur les séries de Gond-

wana, XIXth Congr. Géol. Internat. [Reports a valve of *Chiton* sp. from the Permian of Brazil.]

Miller, S. A. 1889. North American geology and paleontology for the use of amateurs, students and scientists. Western Methodist Book Concern, Cincinnati. 664 pp.

Moore, R. C., C. G. Lalicker, and A. G. Fischer. 1952. Invertebrate fossils. Chitons, pp. 271–273, fig. 2a–c, 3. McGraw-Hill Book Co., Inc., New York. [Brief review of fossil chiton occurrences.]

Morris, N. J. 1967. Amphineura. P. 424 *in* The fossil record. W. B. Harland et al., eds. Geol. Soc., London.

Münster, G. G. zu. 1839. Der *Chiton priscus* und einige andere seltens Versteinerungen aus der Uebergangsformation. Beiträge zur Petrefactenkunde, 1st ed. 1839, Vol. 1, p. 38, pl. 13, fig. 4; 2nd ed., 1843, Vol. 1, pp. 60–61, pl. 13, fig. 4a–e. Buchner'schen Buchhandlung, Bayreuth. [Describes *Chiton priscus.*]

Nicolaus, H. J. 1963. Zur Stratigraphie und Fauna der *Crenestria*-Zone im Kulm des Rheinischen Schiefergebirges. Beihefte zum Geologischen Jahrbuch 53:203, 205, pl. 16, fig. 2a–g, 3; pl. 18, fig. 5. [Mentions *Helminthochiton priscus* and *Lepidopleurus laterodepressus.*]

Oehlert, M. D. 1881. Documents pour servir a l'étude des faunes Dévoniennes dans l'ouest de la France. Mém. Soc. Geol. France, ser. 3, 2(1):15–17, pl. 2, fig. 3a–b. Paris. [Describes two new genera, *Sagmaplaxus* and *Beloplaxus,* and one new species, *S. sarthacensis.*]

Orbigny, A. D. d'. 1850. Prodrome de paléontologique stratigraphique universelle des animaux mollusques et rayonnés faisant suite au cours élementaire de paléontologie, Vol. 1, p. 127. Victor Masson, Paris. [General reference to genus *Chiton* and to species by *Etage* number, and species number. *Chiton priscus, C. concentricus, C. subgemmatus, Chitonellus cordifer.*]

Pictet, F. J. 1844. Traité de paléontologie ou histoire naturelle des animaux fossiles considérés dans leurs rapports zoologiques et géologiques. 1st ed., Vol. 3, p. 300; 2nd ed., 1855, Vol. 3, Les oscabrions (*Chiton,* Linn., *Cryptoplax* Gray), pp. 300–302, Atlas, pl. 69, fig. 18–19. J.-B. Baillière et fils, Paris. [Lists and comments on a number of fossil species from the Devonian, Carboniferous, Permian, Jurassic, and the Tertiary.]

Pilsbry, H. A. 1892. Monograph of the Polyplacophora: manual of conchology 14:1–350, pl. 1–68. Academy of Nat. Sci., Philadelphia.

——. 1900. Amphineura. Pp. 433–436 *in* Textbook of paleontology, Eastman translation, K. A. von Zittel, ed. [Also, 2nd ed., 1913, pp. 510–513, text-fig. 841–842]. MacMillan and Co., London. [Classifies the Paleozoic genera under a new family (Gryphochitonidae). Discusses *Dusilia insignis* Jahn.]

Plas, L. F., Jr. 1972. Upper Wolfcampian(?) Mollusca from the Arrow Canyon Range, Clark County, Nevada. J. Paleontol. 46(2):249–260, 1 pl. [Mentions presence of *Helminthochiton* sp. and an unknown genus and species.]

Pompeckj, J. F. 1912. Amphineura—Paläontologie. Handwörterbuch der Naturwissenschaften, Vol. 1, pp. 354–357, text-fig. 1–3. Gustav Fischer, Jena. [A short general review of fossil polyplacophorans. Discusses *Duslia insignis* Jahn.]

Quenstedt, F. A. 1852. Handbuch der Petrefaktenkunde. P. 445. H. Laupp, Tübingen. [Describes *Chiton priscus* Münster.]

——. 1882. Petrefaktenkunde Deutschlands-Gasteropoden, Vol. 7, 867 pp., Atlas, pl. 186–218. L. F. Fues, Leipzig.

Quenstedt, W. 1931. Loricata (Paläontologie). Handwörterbuch Naturwissenschaften, 2nd ed., Vol. 6, pp. 552–555, fig. 1–3. Gustav Fischer, Jena.

——. 1932. Die Geschichte der Chitonen und ihre allgemeine Bedeutung. Paläont. Zeit. 14(1–2):77–96, text-fig. 1. [A useful summary of existing knowledge, with references to earlier literature.]

Quoy, J. R. C. and J. P. Gaimard. 1835. Voyage de découvertes d'Astrolabe. Zoologie, Vol. 3, 954 pp., 9 pl. Pillet aîné, Paris.

Raymond, P. E. 1910. A preliminary list of the fauna of the Allegheny and Conemaugh series in western Pennsylvania. Ann. Carnegie Mus. 7(1):153–154, pl. 24, fig. 11–12, pl. 26, fig. 6, pl. 28, fig. 14–16. [Describes genus *Glaphurochiton,* with *C. carbonarius* (Stevens) as type species, and *Glaphurochiton simplex.*]

——. 1911. Pa. Topo. and Geol. Surv., Rept. for 1908–1910, pp. 83–98, pl. 3, fig. 11, 12; pl. 5, fig. 4. [Lists and illustrates *Glaphurochiton simplex* and *G. carbonarius.*]

Reed, F. R. C. 1907. Sedgwick Museum Notes. Crustacea, etc., from Girvan. Geol. Mag., ser. 2, decade 5, 4:113–114, pl. 4, fig. 8–14. [Lists *Helminthochiton grayiae* Woodward, 1885 and *Chiton* sp. from the Lower Silurian.]

——. 1911. A new fossil from Girvan. (I.— Sedgwick Museum Notes). Geol. Mag., decade 5, 8(8):337–339, pl. 15. [Describes *Helminthochiton thraivensis* from the Upper Ordovician. Figures 7, 7c show girdle spicules.]

Reeve, L. A. 1847. Monograph on the genus *Chiton.* Conchologia iconica, Vol. 4, pl. 1–28, fig. 1–194. Reeve Brothers, London.

Reso, A. 1963. Composite columnar section of exposed Paleozoic and Cenozoic rocks in the Pahranagat Range, Lincoln County, Nevada. Bull. Geol. Soc. Am. 74(7):901–918, pl. 2. [Lists *Matthevia* sp. from the Desert Valley Formation.]

Rhoads, D. C. 1962. Microfossils of problematical affinity from the Maquoketa Formation of eastern Iowa and western Illinois. J. Paleontol. 36(3):1334–1340, text-fig. 1A–D, 2A–D, 3A–B, pl. 178, fig. 1–16. [Describes three new genera (*Bursata, Subcylindrica, Triangulata*) and six new species of tegmates from the Upper Ordovician, subsequently described as polyplacophoran. See Sanders (1965).]

Richardson, E. S., Jr. 1956. Pennsylvanian invertebrates of the Mazon Creek area, Illinois. Fieldiana: Geology, Chicago Nat. Hist. Mus. 12(3):61–65, fig. 34–36. [Describes *Helminthochiton concinnus.* Figures show impression of radula.]

Robson, G. C. 1913. *Helminthochiton aequivoca,* n. sp., Lower Ordovician, Bohemia. Geol. Mag., decade 10, 10:302–304, text-fig. 1–3.

Rochebrune, A. T. de. 1883. Monographie des espèces fossiles appartenant à la Classe des Polyplaxiphores. Annales des Sciences/Géologiques, Vol. 14, Art. 1, pp. 1–74, pl. 1–3. Paris (1882). [A general account, listing 69 species considered valid, by geological age, and 30 *Species incertae.* Describes 25 new Tertiary species. Most of Rochebrune's descriptions and figures are inadequate and cannot be used for reliable identification.]

Roemer, C. F. von. 1851. Kohlen Periode (Silur-, Devon-, Kohlen- und Zechstein-Formation, 2. Palaeo-Lethaea. Bd. 1, Theil II, pp. 447–448, pl. 3, fig. 18 *in* Lethaea Geognostica oder Abbildung und Beschreibung der für die Gebirgs-Formationen bezeichnendsten Versteinerungen, H. G. Bronn and C. F. Roemer. E. Schweizerbart, Stuttgart.

——. 1876. Lethaea geognostica oder Beschreibung und Abbildung der für die Gebirgs-Formationen bezeichnend-

sten Versteinerungen, Theil I, Lethaea Palaeozoica, Bd. 1, Atlas, pl. 45, fig. 22. J. C. Henzler, Stuttgart. [Gives an illustration of *Chiton priscus* Münster.]

Roemer, F. A. 1843. Die Versteinerungen des Harzgebirges. P. 32, pl. 9, fig. 5. Hahn, Hannover. [*Bellerophon expansus* Sowerby—a polyplacophoran according to de Koninck (1883, p. 199).]

———. 1855. Beitrage zur geologischen Kenntniss des nordwestlichen Harzgebirges. Palaeontogr. 5(1):36, pl. 7, fig. 8a–b, 9a–b, pl. 22, fig. 9. [Describes *Chiton laevigatus.*]

Rolfe, I. W. D. 1981. *Septemchiton*—a misnomer. J. Paleontol. 55(1):675–678, text-fig. 1–3.

Rowley, R. R. 1908. The geology of Pike County. Mo. Bur. Geology and Mines, 2nd ser., 8:90, pl. 19, fig. 15–19. [Describes *Platyceras? anomalum.*]

Runnegar, B. and J. Pojeta, Jr. 1974. Molluscan phylogeny: the paleontological viewpoint. Science 186(4161):311–317, fig. 3A–O, 4–5. [Illustrates *Chelodes* sp. from the Ordovician of Australia.]

Runnegar, B., J. Pojeta, Jr., M. E. Taylor, and D. Collins. 1979. New species of the Cambrian and Ordovician chitons *Matthevia* and *Chelodes* from Wisconsin and Queensland: evidence for the early history of polyplacophoran mollusks. J. Paleontol. 53(6):1374–1394, pl. 1–3, text-fig. 1–4. [Describes *Matthevia variabilis* Walcott, *Matthevia walcotti* n. sp., *Chelodes whitehousei* n. sp., *Helminthecella expansa* Ulrich and Bridge, and *Preacanthochiton cooperi* Bergenhayn].

Ryckholt, P. de. 1845. Résumé géologique sur le genre *Chiton* Lin. Bulletin de l'Académie Royale des Sciences et des Belles-Lettres de Bruxelles 12(7):36–62, pl. 1–4. [An important contribution describing 11 new Paleozoic species and commenting on 4 already described. Lists 2 Tertiary species.]

———. 1852. Mélanges Paléontologiques—Chitonidae. Mémoires Couronnes et Mémoires des Savants étrangers. L'Académie Royale des Sciences, des Lettres et des Beaux-Arts de Belgique 24:63–65, pl. 2, fig. 35–38 (1850–51). [Describes *Chiton scaldianus, C. slusianus,* and *C. barrandeanus.*]

———. 1862. Description de deux tuniciers carbonifères et d'un nouveau genre de la famille des Chitonidae. J. Conchyl., ser. 3, 2(3):259–260, pl. 12, fig. 14. [Describes *Sulcochiton grayi.* Probably not a polyplacophoran.]

Salter, J. W. 1847. Description of a fossil chiton from the Silurian rocks, with remarks on the fossil species of the genus. Quart. J. Geol. Soc. London 3:48–52, text-fig. 1–6. [Describes genus *Helminthochiton* and gives a list of fossil species.]

Sandberger, F. 1845. Kurtze Bemerkungen zu der Schrift von F. A. Roemer: "die Versteinerungen des *Harz-Gebirges,* mit XII Steindruck-Tafeln. Hannover, 1843." Neues Jahrbuch für Mineralogie, Geognosie, Geologie und Petrefakten-Kunde, p. 439. Stuttgart. [For *Chiton cordiformis.*]

Sandberger, G. 1842. Vorläufige Übersicht über die eigenthümlichen bei Villmar an der Lahn auftretenden jüngeren Kalk-Schichten der älteren (sog. Uebergangs-) Formation, besonders nach ihren organischen Einschlüssen, und Beschreibung ihrer wesentlichsten neuen Arten nebst einem Vorwert über Namengebung in der Naturbeschreibung überhaupt und in der Palëontologie insbesondere. Neues Jahrbuch für Mineralogie, Geognosie, Geologie und Petrefakten-Kunde, 1842, pp. 387, 399. Stuttgart. [Describes *Chiton priscus* Münster, *C. subgranosus,* and *C. fasciatus* as new.]

Sandberger, G. and F. Sandberger. 1856. Die Versteinerungen des Rheinischen Schichten Systems in Nassau. Genus *Chiton,* pp. 237–240, pl. 26, fig. 22, 22a–d, 23, 23a–d. Quarto, 1850–56. Kreidel and Niedner, Wiesbaden. [Describes *Chiton corrugatus* and *C. sagittalis* from the Devonian.]

Sanders, R. B. 1962. Conodonts of the Beaverfoot-Brisco formations, Ordovician of British Columbia. Unpublished Masters Thesis, 102 pp., Univ. Iowa. [For microfossils questionably similar to *Septemchiton iowensis* Sanders, 1965. Noted as tegmates, *Bursata iowensis.*]

———. 1965. A new species of *Septemchiton.* Proc. Okla. Acad. Sci. for 1964, pp. 94–98, fig. 1–12. [Describes *Septemchiton iowensis* from the Upper Ordovician.]

Sardeson, F. W. 1896. The fauna of the Magnesian series. Bull. Minn. Acad. Nat. Sci. 4(1):102, pl. 6, fig. 8–10. [Describes *Ascoceras gibberosum.*]

Schmidt, H. 1951. Neue Faunen aus dem Namur des nordöstlichen Spaniens. Paläontol. Zeitschr. 24:184–193, pl. 13, fig. 11. [Lists and figures *Helminthochiton* aff. *gemmatus* (de Koninck).]

Shimer, H. W. and R. R. Shrock. 1944. Index fossils of North America. Order Polyplacophora, pp. 526–527, pl. 216, fig. 1–37. John Wiley & Sons, Inc., New York. [A review of fossil polyplacophoran genera, with their geological age distribution.]

Simroth, H. 1893. Amphineura. Pp. 311–313, 351, text-fig. 37, 40 *in* Klassen and Ordnungen des Tier-Reichs, Bd. 3, Mollusca (Weichtiere), H. G. Bronn, ed. C. F. Winter, Leipzig and Heidelberg. [Brief discussion of fossil records. Illustrates *Gryphochiton priscus* Münster, and *Dusliae insignis* Jahn.]

Sirenko, V. I. and Y. I. Starobogatov. 1977. K sistematike paleozoyskikh i mezozoyskikh khitonov. Paleontol. Zhur. 3:30–41, fig. 1–3. [English translation by the Amer. Geol. Inst., Paleontol. Journal 11(3):285–294, fig. 1–3, 1977.]

Smith, A. G. 1960. Amphineura. Pp. 141–176, fig. 31–45 *in* Treatise on invertebrate paleontology Part I, Mollusca 1, R. C. Moore, ed. Geol. Soc. Amer. and Univ. Kans. Press, Lawrence, Kansas. [A general account, with a systematic classification including all described genera with their type species.]

———. 1971. The Carboniferous genus *Glyptochiton* de Koninck, 1883 (Mollusca: Polyplacophora). Proc. Calif. Acad. Sci., 4th ser., 37(22):567–574, fig. 1–15.

———. 1973. Fossil chitons from the Mesozoic—a checklist and bibliography. Calif. Acad. Sci., Occas. Paper 103, 30 pp.

———. 1976. Two new Permian chitons from West Texas (Mollusca: Polyplacophora). The Veliger 18(3):281–288, fig. 1–34. [Describes *Pterochiton arthurcooperi* and *P. newelli.*]

Smith, A. G. and D. F. Toomey. 1964. Chitons from the Kindblade Formation. Okla. Geol. Surv., Cir. 66:1–41, pl. 1–8, text-fig. 1–2. [Describes two new genera, *Paleochiton* and *Eochiton,* and five new species from the Lower Ordovician.]

Sowerby, J. de C. 1839. Fossil shells in the lowest beds of the Old Red Sandstone and fossil shells of the upper Ludlow rock. Pp. 602–604, 608–613, pl. 5, fig. 32 *in* The Silurian System, R. I. Murchison, ed. John Murray, London. [*Bellerophon expansus.*]

Špinar, Z. 1965. Systematická paleontologie bezobratlých, pp. 318–320, fig. VIII-8–9, Academia Nakladatelství Československé Academie Věd, Praha. [Short discussion of classification and illustrates *Chelodes bohemicus* (Barrande) and *Helminthochiton? secundus* Horný.]

Starobogatov, Y. I. and V. I. Sirenko. 1975. The system

of the Polyplacophora. Pp. 21–23 *in* The Mollusca, their system, evolution and natural role, fasc. 5. Nauka Press.

Stevens, R. P. 1858. Description of new Carboniferous fossils from the Appalachian, Illinois, and Michigan coalfields. Amer. J. Sci. and Arts, ser. 2, 25(74):264. [Describes *Chiton carbonarius* and *C. parvus.*]

Stait, B. and C. Burrett. 1984. Early Ordovician polyplacophoran *Chelodes whitehousei* from Tarutao Island, southern Thailand. Alcheringa 8:112, fig. 1.

Stromer von Reichenbach, E. 1909. Lehrbuch der Paläozoologie. 1, Wirbellose Tiere, pp. 196–197, fig. 230. Leipzig and Berlin. [Gives an illustration of *Gryphochiton priscus* (Münster).]

Stuckenberg, A. 1898. Allgemeine geologische Karte von Russland. Blatt. 127. Russia, Geologicheskii Komitet, Trudy (Comité géologique, Mémoires), Vol. 16, no. 1, pp. 163, 364, pl. 3, fig. 25a–b. [Lists and figures *Chitonellus antiquus* (Howse).]

Thiele, J. 1909. Revision des Systems der Chitonen. Zoologica, Vol. 22, no. 56, pp. 1–70, pl. 1–6, text-fig. 1–5; 1910, pp. 71–132, pl. 7–10.

Trenkner, W. 1868. Paläontologische Novitaten von Nordwestlichen Harze. I. Ibergerkalk und Kohlengebirge von Grund. Abhandlungen der Naturforschenden Gesellschaft zu Halle, Bd. 10, Chitons, pp. 135–138, pl. 2, fig. 26–33. [Describes seven new species from the Upper Devonian and lists two already described. Figures are extremely stylized enlargements and their identification as polyplacophorans from these is questionable.]

Tryon, G. W., Jr. 1883. Manual of structural and systematic conchology. An introduction to the study of the Mollusca, Vol. 2, pp. 339–340, pl. 85, fig. 64–67. G. W. Tryon, Philadelphia. [Brief account of extinct forms.]

Turek, V. and R. J. Prokop. 1982. Two remarkable finds of molluscs in the Carboniferous of Slovakia. Casopis pro Mineralogii a Geologii 27(3):285–293, pl. 2, text-fig. 2. [Describes *Rhombichiton ochtinensis.*]

Van Belle, R. A. 1975*a*. Sur la classification des Polyplacophora: I. Introduction et classification des Paleoloricata, avec la description de *Kindbladochiton* nom. nov. (pour *Eochiton* Smith, 1964). Informations de la Société Belge de Malacologie, ser. 4, no. 5, pp. 121–131, pl. 1, fig. 1–11.

———. 1975*b*. Sur la classification des Polyplacophora: II. Classification systématique des Lepidopleurina (Neoloricata), avec la description des Helminthochitoninae nov. subfam. (Lepidopleuridae) et de *Mesochiton* nov. gen. (Helminthochitoninae). Informations de la Société Belge de Malacologie, ser. 4, no. 6, pp. 135–145, pl. 2–3.

———. 1978. Sur la classification des Polyplacophora: VII. Errata, additions et rectifications. Résumé de la classification. Index alphabétique. Informations de la Société Belge de Malacologie, ser. 6, no. 3, pp. 65–82.

Walcott, C. D. 1885. Note on some Paleozoic pteropods. Amer. J. Sci. 30:17, pl. 20, fig. 1–6.

———. 1886. Studies on the Cambrian faunas of North America. U.S. Geol. Surv. Bull. 30:223–225, pl. 32, fig. 1–12, pl. 33, fig. 1, 1a–f. [Describes *Matthevia variabilis.*]

———. 1912. New York Potsdam-Hoyt fauna, in Cambrian geology and paleontology. Smithson. Misc. Coll. 57(9):251–304, pl. 37–49.

Wanless, H. R. 1958. Pennsylvanian faunas of the Beardstown, Glasford, Havana, and Vermont quadrangles. Ill. Geol. Surv., Rept. Invest. 205, pp. 21, 39. [Lists *Glaphurochiton carbonarius* (Stevens).]

Weller, S. 1903. The Paleozoic faunas. New Jersey Geol. Surv., Paleontology 3:173–174, pl. 13, fig. 1–10. [Describes an unnamed polyplacophoran plate from the Trenton Limestone.]

Whidborne, G. F. 1892. A monograph of the Devonian fauna of the south of England. Palaeontogr. Soc. 2(4):333–335, pl. 31, fig. 15a, b, 16. [Describes *Helminthochiton papilio.*]

Whitfield, R. P. 1882. On the fauna of the lower Carboniferous limestones of Spergen Hill, Ind., with a revision of the descriptions of its fossils hitherto published, and illustrations of the species from the original type series. Bull. Amer. Mus. Nat. Hist. 1(5):96. [Lists *Chiton carbonarius* Stevens.]

Williams, J. S. 1943. Stratigraphy and fauna of the Louisiana Limestone of Missouri. U.S. Geol. Surv. PP 203:100–101, pl. 9, fig. 19–20. [Describes *Gryphochiton? anomalus* (Rowley).]

Wilson, A. E. 1951. Gastropoda and Conularia of the Ottawa Formation of the Ottawa–St. Lawrence lowland. Geol. Surv. Canada, Bull. 17, p. 16, pl. 1, fig. 1–3. [Describes *Priscochiton canadensis* Billings.]

Withers, T. H. 1926. Catalogue of the Machaeridia (*Turrilepas* and its allies) in the Department of Geology British Museum (N.H.), pp. 34–42, pl. 5, fig. 1–6, pl. 6, fig. 1–8. [Discusses "*Chiton*" *wrightianus* de Koninck, a barnacle.]

Wood, W. 1815. General conchology: or, a description of shells, arranged according to the Linnean system and illustrated with plates, drawn and coloured from nature, Vol. 1. John Booth, London. 246 pp.

Woodward, H. 1865. On the discovery of a new genus of Cirripedia in the Wenlock limestone and shale of Dudley. Quart. J. Geol. Soc. London 21(4):486–489, pl. 14, fig. 1a–l. [Good discussion of *Chiton wrightianus, C. loftusianus,* and *C. grayanus* with respect to their validity as polyplacophorans.]

———. 1885. On a new species of *Helminthochiton* from the Upper Bala (Silurian) of Girvan, Ayrshire. Geol. Mag., decade III, 2:352–355, pl. 9, fig. 7–11. [Describes *Helminthochiton grayiae.*]

Yochelson, E. L. 1966. Mattheva, a proposed new class of mollusks. U.S. Geol. Surv. PP 523-B:B1–B9, pl. 1.

———. 1971. The Permian nautiloid mandible *Rhynchoteuthis kaibabensis* reinterpreted as a polyplacophoran. J. Paleontol. 45(1):130–133, 1 fig. [Describes *Cymatochiton? kaibabensis* (Brady).]

Yochelson, E. L., J. F. McAllister, and A. Reso. 1965. Stratigraphic distribution of the Late Cambrian mollusk *Matthevia* Walcott, 1885. In Geological Survey Research, 1965, U.S. Geol. Surv. PP 525-B:B33–B78, fig. 1–5. [Gives localities where *Matthevia* occurs in California, Nevada, Texas, and Utah.]

Yochelson, E. L. and E. S. Richardson, Jr. 1979. Polyplacophoran molluscs of the Essex fauna (Middle Pennsylvanian, Illinois). Pp. 321–332, fig. 1–5 *in* Mazon Creek Fossils, H. Nitecki, ed. Academic Press, New York. [Discusses *Pterochiton concinnus* (Richardson).]

Yochelson, E. L. and B. W. Saunders. 1967. A bibliographic index of North American Late Paleozoic Hyolitha, Amphineura, Scaphopoda, and Gastropoda. U.S. Geol. Surv., Bull. 1210:11–13.

Yochelson, E. L. and M. E. Taylor. 1974. Late Cambrian *Matthevia* (Mollusca, Matthevida) in North America. Geol. Soc. Amer. Abstr. for 1974, Northeastern Section, p. 88.

YOUNG, J. 1865. Provisional notice of a new *Chiton*, and a new species of *Chitonellus*, from the Carboniferous rocks of western Scotland; with descriptions by Mr. James W. Kirkby. Trans. Geol. Soc. Glasgow 2(1):13–15, pl. 1, fig. 1–2. [Describes *Chiton humilis* Kirkby and *Chitonellus youngianus* Kirkby.]

———. 1878. On *Chitonellus*, recent and fossil. Proc. Nat. Hist. Soc. Glasgow 3:322–324. [A general account adding no new information; not of taxonomic significance.]

YOUNG, J. AND J. YOUNG. 1868. *In* On new forms of Crustacea from the Silurian rocks at Girvan, J. Young. Proc. Nat. Hist. Soc. Glasgow 1:169–173, pl. 1, fig. 7a–b. [Describes *Solenocaris solenoides*.]

YÜ, WEN. 1984. Early Cambrian molluscan faunas of Meischucun Stage with special reference to Precambrian–Cambrian boundary. A Special Paper on the "Academia Sinica Developments in Geoscience, Contrib. to 27th Internat. Geol. Cong., Moscow," pp. 21–35, pl. 1, fig. 1–9. [Describes *Yangtzechiton elongatus* n. gen., n. sp. and *Luyanhaochiton spinus* n. gen., n. sp.]

ZITTEL, K. A. VON. 1885. Handbuch der Palaeontologie, Abth. 1, Bd. 2, Placophora, pp. 172–174, fig. 209. R. Oldenbourg, Munich and Leipzig. [Brief mention of fossil occurrences.]

———. 1924. Grundzüge der Paläontologie (Paläozoologie). Neubearbeitet von Dr. Ferdinand Broili, O. Professor an der Universität München. Chitons (Amphineura), pp. 435–437, fig. 802–803. R. Oldenbourg, Munich and Berlin. [Brief general account. Illustrates *Chiton* (*Gryphochiton*) *priscus* Münster and *Lepidopleurus virgifer* Sandberger.]